

# THE PSYCHOLOGICAL BULLETIN

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## TRENDS IN MODERN PSYCHOLOGY

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In psychology as in other sciences the foci of interest are constantly shifting. New problems appear, new methods of approach are worked out, and new points of view are attained. Coincidentally questions that formerly attracted much attention gradually lose their interest for the majority of workers as other and perhaps more promising lines of investigation are brought to light.

In this paper I have attempted to show the nature and extent of some of these changes in so far as they are indicated by the proportionate number of publications on certain topics that have been listed in the *Psychological Index* since its first issue in 1894. Because the system of classification used in the *Index* has undergone several revisions during this period, a certain amount of reclassification was necessary in handling the data from the earlier volumes. In making these reclassifications, the present system was adhered to as closely as possible. The general procedure followed with each topic was first to read through the entire list of titles classified under that head in the 1930 and 1931 volumes, then to read through all sections in the earlier volumes that seemed at all likely to include titles that would now be classified under the topic in question and to make whatever changes seemed necessary in order to make the earlier schemes of classification correspond with the later ones. Sometimes it was possible to shift entire sub-sections; at other times it was necessary to read through all the titles in certain sections and select those which it was thought would now be classified under a different heading. In doubtful cases the original articles were consulted whenever possible. Although the classification of scientific literature is at best a very



difficult matter, since many of the titles might justifiably be placed under any one of several headings, it is believed that the method used is accurate enough to indicate the changing trends of interest in certain of the topics with which psychology has been actively concerned during the past forty years.

*Sensation and perception*<sup>1</sup> have been among the leading topics of psychological interest since the founding of the early German laboratories. From 1894 to 1912 almost one-sixth of all titles listed in the *Index* were classified under these heads. At about that time, particularly in America, the increasing interest in mental tests began to show its effect upon the number of publications dealing with the more conventional topics. The outbreak of the war brought a marked reduction in the number of publications by German psychologists<sup>2</sup> who have always contributed extensively to this field. From 1914 to 1919 the titles dealing with sensation and perception comprise only about one-twelfth of the volume whereas they formerly made up a sixth of it. At the close of the war there is a temporary renewal of interest in this field which lasts, roughly speaking, until about 1925, since when the number of titles has failed to keep pace with the increasing size of the annual volume. The absolute numbers have not shown much change but the proportion has dropped back to its wartime level. (See Figure 1.)<sup>3</sup>

<sup>1</sup> Sensation and perception as classified here includes the following sections from the earlier volumes of the *Index*.

1894-1899. All titles listed under *Sensation*.

All titles listed under *Organs of sense and movement* except a small number dealing with *Effector organs*.

All titles listed under *Perception of time, objects, space, etc.*

Selected titles from *Disorders of sensation and perception*.

1898-1911. As above with the addition of the section on *Normal illusions* which was added to the *Index* in 1898 and in 1899 was changed to read *Normal illusions and normal suggestion*.

1911-1931. *Sensation and perception* as given, except for the elimination of titles on *Statistical methods*, most of which were included in this section before a separate classification was provided for them.

<sup>2</sup> The total number of titles in the *Index* shows only a small reduction until the year 1918 when only 1,585 titles are listed. This is the smallest volume since 1895. Since then the increase has been very rapid. In 1922 the number of titles was 4,077; in 1931 it was 6,792.

<sup>3</sup> The curves based upon the data from the *Psychological Index* and the *Psychological Abstracts* have been subjected to a three-point smoothing; those from the papers read at the American Psychological Association have been given a five-point smoothing.



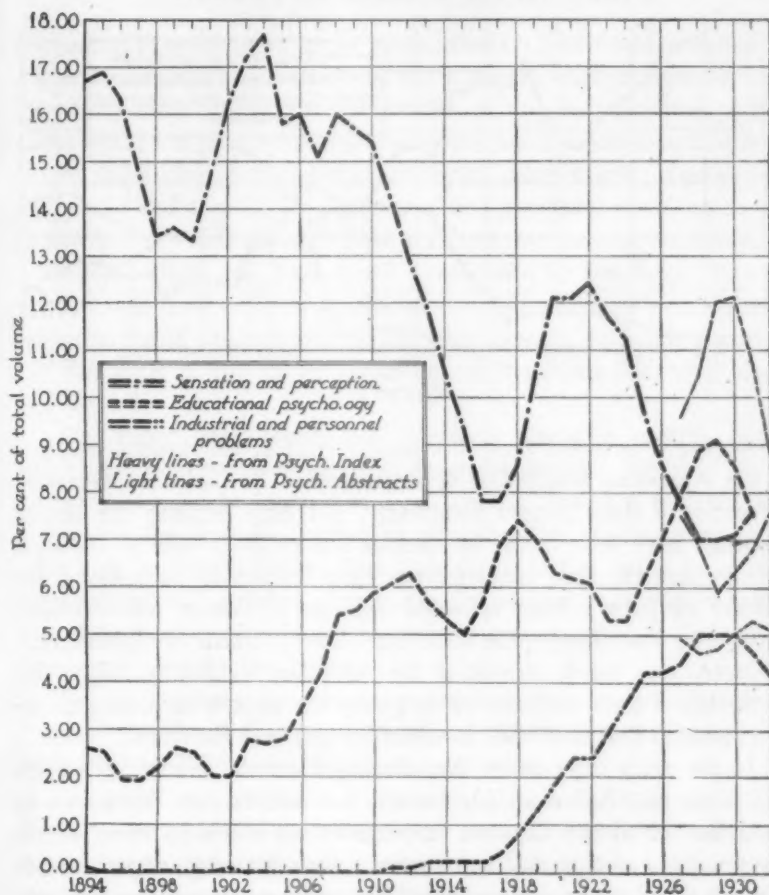


FIGURE 1

The short curves at the right-hand side of Figure 1 are derived from the corresponding titles in the *Psychological Abstracts* from 1927 to 1932. No changes in classification have been made. The proportions run a little lower than those from the *Index* but the differences average rather less than 1 per cent. The fact that the *Index* includes, on the average, about 1,600 more titles than the *Abstracts*<sup>4</sup> indicates that the journals not covered by the *Abstracts* contain slightly more than the average number of publications in this field.

<sup>4</sup> Not counting the first volume of the *Abstracts* which is decidedly incomplete owing to the fact that not all the arrangements for abstracting had been made at that time.



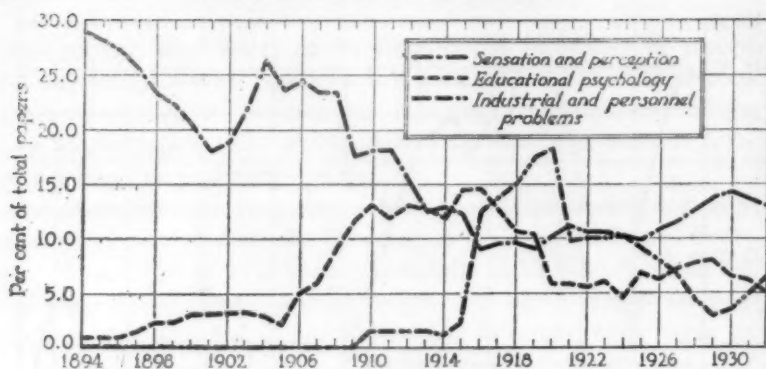


FIGURE 2

Figure 2 is based upon the papers read at the annual meetings of the American Psychological Association. It has been necessary to reclassify these papers completely, not only because the section meetings have been called by various names from time to time but also because the time requirements have frequently necessitated the shifting of papers from crowded sections to others whose official topics may have been quite different. The problem of classification, however, was much simplified by reference to the accompanying abstracts. I have endeavored to group the papers according to the same plan as that now used in the *Abstracts* and the *Index*.

In the early days of the Association when the number of papers was small and American psychology was still largely dominated by the influence of the German laboratories at which so many of the psychologists of that day had received their training, approximately a fourth of all the papers presented had to do with sensation and perception. From 1909 until the close of the war the proportion steadily decreases, though it never falls much below 10 per cent of the total number of papers given. The immediate post-war increase is slight but, contrary to the findings from the *Index*, the last few years have shown an increase rather than a decrease in the proportionate number of papers on this topic.

*Educational psychology.*<sup>5</sup> This is a topic that is hard to classify

<sup>5</sup> The method followed in reclassifying the earlier volumes of the *Index* was as follows:

1894-1897. Includes all titles from section headed *Child Psychology*, *Pedagogy* except those that were selected for the sections on *Childhood and Adolescence*. (See footnote on p. 88.)

1898-1910. Includes all titles listed under *Pedagogy*. No others.

1911-1931. Includes only titles listed under *Educational Psychology*.



because it is overlapped by so many others. The trend indicated by Figure 1 is probably correct in the main, in that it shows a comparatively small number of publications in this field previous to 1906 and a small but steady increase thereafter but it is obvious that many of the titles classified under other topics, particularly *Mental tests*, *Childhood and adolescence*, *Industrial and personnel problems* as well as many of the articles on animal learning, memory and imagination, work and fatigue, etc., have much significance for this field. It is my opinion that if all titles of significance for the educator were selected, not only would the proportions for each year be decidedly increased but the slope in the curve would be much steeper than that shown in Figure 1.

The curve based upon the *Abstracts* shows a slightly higher percentage of titles than does that from the *Index*. Not only do the proportions average from 2 to 3 per cent higher, but for the years 1930-1931 the absolute number of titles listed under this topic in the *Abstracts* is slightly higher than that given in the *Index* in spite of the smaller total number of titles in the volume.<sup>6</sup> It would appear that the educational field is covered by the *Abstracts* a little more thoroughly than by the *Index*.

Figure 2 shows the corresponding proportions for the papers given at the Psychological Association. There is a steady increase from 1894 to 1916 and a falling off thereafter.

*Industrial and personnel problems.*<sup>7</sup> This is distinctly a post-war development. Careful searching of all sections in the *Index* where it seemed at all likely that articles which would now be classified under this head might be concealed yielded a total of only 7 titles during the 17 year period from 1894 to 1910. In 1911 5 articles are listed and from then until 1916 a few scattering titles appear each year. In 1917 the number jumps to 21. Thereafter the figures increase steadily until 1929 since when there has been a small apparent decrease in the percentages which may, of course, represent only a

<sup>6</sup> The 1932 *Index* was not available at the time this article was written.

<sup>7</sup> The following sections were covered:

1894-1899. Titles selected from *Methods, scope and relations of psychology; Movement and volition, general and particular functions.*

1900-1910. Titles selected from *Individual, class and sex psychology.*

1911-1918. Titles selected from *Special attitudes (invention, advertising, acting, etc.).*

1919-1931. All titles listed under *Industrial and professional applications of psychology.*



temporary fluctuation. The *Abstract* figures correspond very closely to those from the *Index*. (See Fig. 1.)

The first paper on *Industrial and Personnel Problems* was read at the American Psychological Association in 1910 by Seashore. Its title was "The Consulting Psychologist." I have classified this paper under *Industrial and Personnel Problems* because it refers definitely to the function of the psychologist in industry, although other branches of applied psychology are stressed as well. The following year two papers were given, one by Strong on "The rôle of attention in advertising" and the second by Woolley on "The application of experimental psychology to the problem of vocational guidance." From 1915 on the typical program includes at least one session devoted primarily to this topic. The proportion reaches its height during the later years of the war, when approximately a sixth of all the papers read during a period of four years fall within this group. Since then the proportion has dropped to around 5 per cent of the total. (See Fig. 2.)

*Nervous system.*<sup>8</sup> As can be seen from Fig. 3, this topic shows a small initial rise which is probably attributable to more adequate canvassing of the medical journals after the *Index* was fairly under way. The maximum is reached at the beginning of the present century. Since then there has been a steady falling off both in the absolute number of publications on the nervous system that are listed in the *Index* and in the percentage of the entire volume comprised under this head. During the past 30 years the proportion has dropped from over 16 per cent of the total volume to less than 5 per cent. The change would have been even greater if the section on the nervous system classified under *Plant and animal behavior* had not been included. This change is the only exception to the rule that the present *Index* system of classification was followed in preference to the earlier ones. The exception was made because of the difficulty of sorting out the studies on the animal nervous system which were at first listed along with those on the human nervous system. From the titles alone it was often impossible to distinguish between them. In the interest of objectivity it seemed better to make the shift in the later volumes rather than in the earlier ones.

<sup>8</sup> The following sections have been included under *Nervous system*:

1894-1910. All titles classified under *Nervous system* except the section headed *Organs of sense and movement* which was included under *Sensation and Perception* as stated on p. 82.

1911-1931. The section headed *Nervous system* from *Plant and animal behavior* has also been classified here.



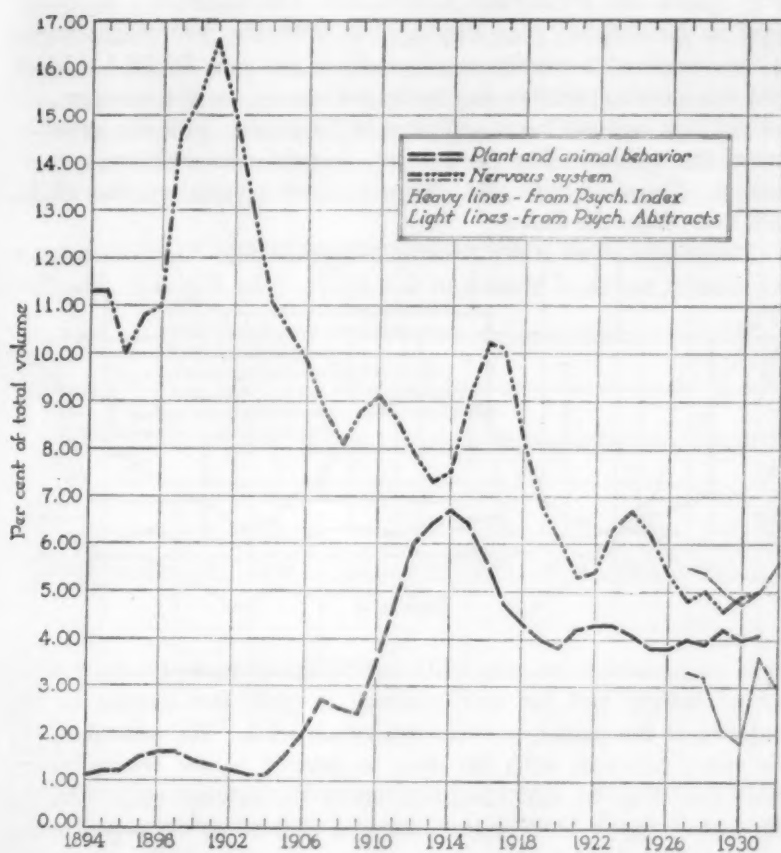


FIGURE 3

The percentages from the *Abstracts* average slightly lower than those from the corresponding years of the *Index*, but the difference is not great.

At the meetings of American Psychological Association the number of papers on this topic has always been small, as a rule not over one or two per year. There has been practically no change in the frequency of these papers since 1894. (See Fig. 4.)

*Plant and animal behavior.*<sup>9</sup> Up to 1905 the number of titles on this topic comprise a little more than 1 per cent of the total number

<sup>9</sup> The following sections have been included under *Plant and animal behavior*: 1894-1910. All titles under *Comparative psychology*. Selected titles from *Instinct and impulse*; *Evolution and heredity*.

1911-1924. All titles under *Plants: organs and responses*. All titles under



listed in the *Index*. (See Fig. 3.) In 1906 the percentages began to rise, reaching a maximum of nearly 7 per cent in 1914. Since then the absolute number has increased slowly, on the average, but the increase has not been sufficient to keep pace with the growing size of the volume. The percentages, therefore, have shown a small decline. The data from the *Abstracts* agree closely, on the whole, with those from the *Index*.

The papers given at the American Psychological Association show two distinct waves of interest in this topic. (See Fig. 4.) The first

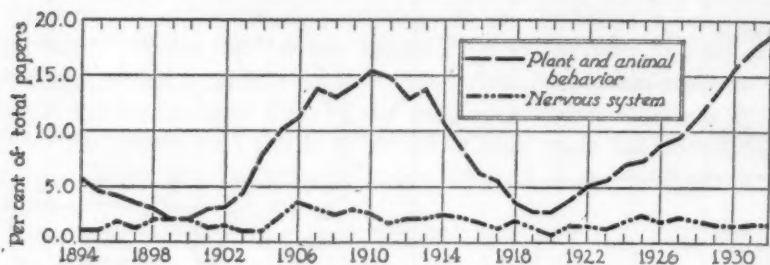


FIGURE 4

wave begins about the year 1903 and continues up to the time when mental testing and the war combine to shift the interest of the majority of the animal workers into other fields. The second rise in the curve coincides with the drop in interest in the testing movement (see Fig. 6) and continues up to the present time. At the Ithaca meeting in 1932 approximately a fifth of all the papers given were in the animal field.

*Childhood and Adolescence.*<sup>10</sup> From 1894 to 1921 not far from 2 per cent of all publications listed in the *Index* deal with the general *Animal psychology and animal behavior*. Selected titles from *Organic evolution and heredity*.

1925-1931. All titles under *Plant and animal behavior* except section on *Nervous system*. (See footnote on p. 86.)

<sup>10</sup> The following sections were covered in selecting titles on *Childhood and Adolescence*:

1894-1897. All titles from section on *Child psychology and pedagogy* except those classified under *Educational psychology*. (See footnote on p. 84.)

1897-1899. Selected titles from *Mental development, theory of evolution and heredity*.

1894-1899. Selected titles from *Particular motor functions*.

1900-1910. Selected titles from *Special motor functions*.

1898-1910. Selected titles from *Individual, sex and class psychology*.

1900-1910. Selected titles from *Adolescence and senescence*.



topic of *Childhood and Adolescence*. Although the slump in the curve from 1914 to 1917 may be a fluctuation of sampling, it is quite possible that it represents a temporary withdrawal of interest from more general problems of child development into the specialized field of mental testing. From 1917 on, however, publications on *Childhood and Adolescence* make up an increasingly greater proportion of the total number listed in the *Index*. In 1922 the percentage is greater

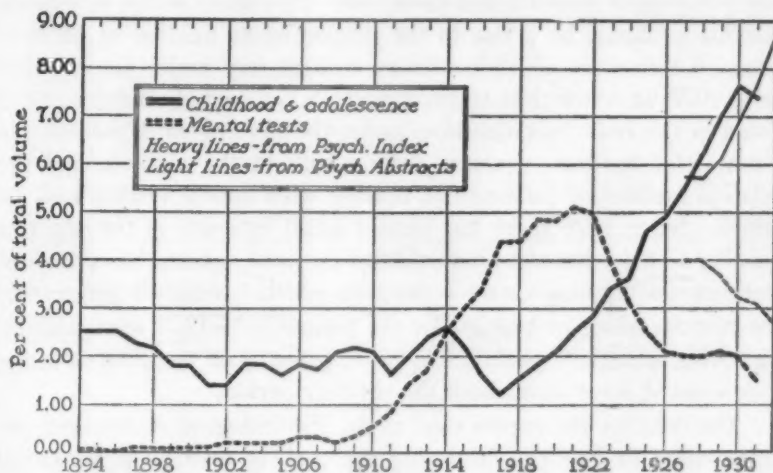


FIGURE 5

than at any time during the preceding 28 years. By 1930 and 1931 the proportion has increased to almost four times the average for the years preceding 1921.

The data from the *Abstracts* correspond fairly closely to those based on the *Index*. The curve shows a continued increase during the year 1932 for which the *Index* figures were not available at the time of writing. These curves are shown in Fig. 5.

The subject of *Childhood and Adolescence* has claimed about the same proportionate attention at the meetings of the American Psychological Association as in the publications listed in the *Index* which covers the foreign as well as the American sources. Although the percentages based on the papers read at the American meetings are slightly higher, on the average, than those obtained from the *Index*

1898-1910. All titles in the section on *Child psychology* except those dealing with Mental tests and a small number of others which would now be classified elsewhere.

1911-1931. Only titles classified under *Childhood and Adolescence*.



the difference is not large when the comparatively small number of papers upon which the percentages for the Association meetings are computed is taken into account. (See Fig. 6.)

*Mental Tests.*<sup>11</sup> Fig. 5 shows that publications on the subject of mental testing constitute an almost negligible proportion of the total number of papers in the *Index* up to the year 1908. About this time, however, the work of Binet began to attract the serious attention of psychologists in America and elsewhere. The result of this increasing interest is shown by a rise in the proportionate number of publications on this topic which continues without any major interruption until 1922, at which time approximately 5 per cent of all publications listed in the *Index* are classified under the heading of *Mental Tests*. From 1922 to 1926, a sharp decline both in the absolute and the relative number of publications dealing with mental testing may be noted. Since 1926 there has been a small increase in the absolute number of titles but the proportion of the total volume has remained stationary at approximately 2 per cent which is only 40 per cent of the corresponding proportion for the period 1920-1922 when interest in testing was at its peak. The curve based upon the *Abstracts* has a downward slope throughout the six-year period.

The data for the papers read at the Psychological Association are represented in Fig. 6. Save that the peak is reached at an earlier date, the general form of the curve for *Mental tests* corresponds very closely to that based on the *Index*, but the percentages are very much higher. The tremendous interest of American psychologists in this subject during the height of the movement is shown by the fact that in 1917, 19 or almost a third of the total number of papers read before the Association had to do with mental testing. In 1932 the proportion had dropped to 4 per cent. Although American interest in testing has been greatly in excess of that shown by psychologists in other countries throughout the period considered, here as elsewhere interest

<sup>11</sup> The following sections were covered in classifying the material on *Mental tests*:

1894-1899. Selected titles from *Mental development, theory of evolution and heredity*.

1894-1899. Selected titles from *Particular motor functions*.

1900-1910. Selected titles from *Special motor functions*.

1898-1910. Selected titles from *Individual, sex and class psychology*.

1898-1910. Selected titles from *Child psychology*.

1911-1914. Selected titles from *Mental inheritance and environment* (inc. *Mental tests*).

1915-1931. Only titles listed under *Mental tests*.



in the topic appears to have undergone a marked decline during the past ten years.

Examination of the literature, however, suggests that the drop during recent years is more apparent than real. It is probably due in large measure to the fact that the field of usefulness for these tests has been fairly well defined and the adequacy of the tests themselves has been pretty well determined. Psychologists have not ceased to

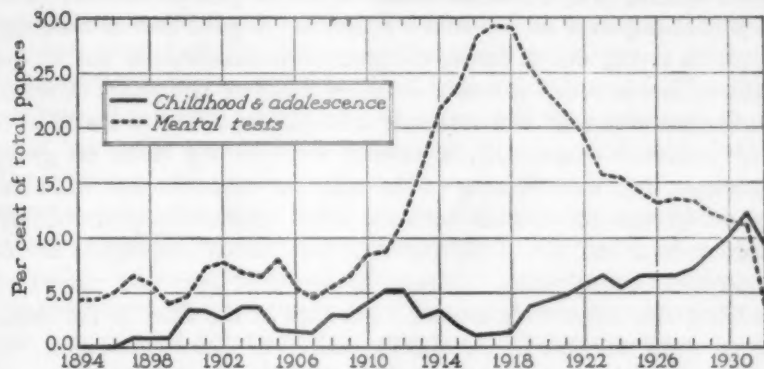


FIGURE 6

use tests but they have been relegated to the position of tools for use in the study of other problems and so are less likely to hold the center of attention.

*Other topics.* According to the *Index* figures, the number of publications on *Statistical methods* has increased fairly regularly since 1914. Previous to that time the topic was represented only by a half-dozen straggling papers or so each year. Since then the number has grown to around fifty or sixty a year which is approximately 1 per cent of the total volume. The number listed in the *Abstracts* is a little greater, both absolutely and in proportion to the total size of the volume, and the proportion among the papers read before the *Psychological Association* is a little higher still, averaging from 2 to 3 per cent of the total since 1915. The first paper dealing purely with statistical procedures in the treatment of data was read by Woodrow in 1910.

Titles classified under *Attention, memory and thought* make up about 3 to 4 per cent of each annual volume of the *Index* since 1894, that is, the annual increase has been proportional to the increase in psychological publication in general. The same appears to be true of the studies on *Work and fatigue* for which the proportion is about



1 per cent; *Sleep and dreams*, about one-half of 1 per cent; *Feeling and emotion*, about 1 to 2 per cent, and *Maldevelopment and mental deficiencies*, from 1 to 2 per cent.

It is regrettable that no reasonably objective method of handling the topics of *Social psychology* and *Abnormal psychology* was devised. The methods of classifying this material in the *Index* have been changed very frequently and the type of material included under a given heading is by no means similar from one year to another. This is particularly true of the earlier volumes. A good deal of time was spent in trying out different methods of reclassification but it was evident that in order to secure even approximate uniformity it would be necessary to read and reclassify a large proportion of the titles in each volume. Eventually, a scheme for selecting titles on group sociology, *i.e.*, titles having to do with the manners and mores of special groups rather than with the social interaction of individuals was worked out, but I do not feel very much confidence in the accuracy of the selection. Taking the figures at their face value, they indicate that somewhere around 8 per cent of the titles in the *Index* come under this head. At the Psychological Association, however, only an occasional paper has dealt with this topic.

Modern psychology rather prides itself on its divorce from philosophy. I was somewhat interested in seeing how complete a separation has been made. Since there has been no time when the *Index* has included a section definitely labeled *Philosophy* it seemed necessary to approach the problem in some other way. I accordingly read completely through the volumes for 1900, 1910, 1920, 1930 and counted the number of titles in each that contained the word *philosophy*, *philosopher* or any one of such distinctly philosophic term as *positivism*, *monism*, *metaphysics*, *epistemology*, and the like. It would have been desirable, I now think, to have counted the titles containing the names of the older philosophers, such as Spinoza and Kant as well but this was not done. Had such titles been included it would have markedly increased the totals for the two earlier volumes but would have had little effect upon the later ones.

The percentages obtained were as follows:

1900	1910	1920	1930
6.9	5.6	1.0	0.7

The major break occurs between the years 1910 and 1920. It coincides, therefore, with the rise of interest in behaviorism.

*Reliability of the findings.* Everyone who has attempted the task of classifying scientific publications is aware of the difficulties



involved. Fine distinctions are not feasible when, as often happens, one has only a title to go by and even classification within broad general groups may involve an appreciable margin of error. For this reason the figures obtained in a study of this kind cannot be regarded as sufficiently accurate to do more than indicate general trends. That the trends shown in Figures 1 to 6 are not simply the result of chance or of irregularities in the systems of classification used seems practically certain in view of the close agreement between the data taken from the *Index* and that from the *Abstracts* over the short period of time covered by the latter, and more especially when one notes the general resemblance in the form of these curves to those based upon the papers read before the *Psychological Association*. The *Abstracts* and the *Index* have the same editorial board and presumably cover the same field, except that the *Index* includes, at present, about 25 per cent more titles than the *Abstracts*. A general agreement between the two classifications is therefore to be expected. But the papers read before the *Psychological Association* which show only the trend of American psychology and which were classified by the writer have much the same general tendencies as those for the other sources which include foreign publications as well. The chief exceptions are to be seen in the curves for *Nervous System* which are consistently lower for the American papers than for the total group; and in the recent increase of interest in the topic of *Animal Behavior* which is not paralleled by any observable change in the percentages from the *Index*. The interest in mental testing reached a much higher level in America than that indicated by the *Index* publications but the general trend of the two curves is much the same. It might be mentioned in this connection that there appears to be a growing tendency for American psychology to break away from the European traditions. As a matter of interest I have worked out rank order correlations between the percentages represented by each of the seven topics shown in Figures 1 to 6 in the *Index* and the *Association* papers respectively for a number of sample years taken at random over the period covered by this study. The results are not worth presenting in detail since the number of topics considered is so small that the individual figures vary considerably from year to year but the general tendency is quite apparent. Those for the first half of the period are all positive with a median value of around  $+.60$ ; those for the latter half are much lower and for the past few years a negative tendency is indicated. These correlations, it must be remembered, since they are based upon the comparative magnitudes of the



percentages of papers on a given topic in each of the two sources considered in any single year do not indicate the uniformity of trends in interest as shown over a period of years. As a matter of fact, the topic which has had the greatest influence in lowering the correlations during the latter half of the period is *Mental tests*. Although, as can be seen from Figures 5 and 6, the general form of the two curves is very similar, the enormous preoccupation of American psychologists with this topic has resulted in a great disparity of the percentages from the two sources. The recent increase of interest in animal psychology in America has provided an additional source of discrepancy. During the earlier part of the period, the chief differences were in the proportion of papers on the *Nervous system*.

It must be admitted, however, that any system of classification must of necessity be somewhat arbitrary. Probably no two psychologists, if left to themselves with only section headings as a guide, would always classify each paper in the same way, even after reading it. Since this is true, the question of reliability of classification resolves itself into one of consistency of procedure, rather than of adherence to any one of the varying systems of classification that may seem desirable to this psychologist or to that one. As I indicated at the beginning of this paper, my attempt has been not to impose my own system of classification upon that at present used in the *Index* (which would merely mean the substitution of one fallible judgment for another), but, by careful examination of the present system to make such modifications in the earlier arrangements as would make them conform as nearly as possible to the present one. The question asked in each instance was not where, in my own judgment, a given title or sub-section ought to be placed but where it seemed most likely that it would be placed by the present editors. One test of the adequacy of such a reclassification is to be found in the absence of marked shifts in the percentages on the years when the system of classification was revised. These years are indicated in the footnotes. By far the most drastic of these revisions occurred in 1911. Neither at this time, however, nor at any of the other periods when the plan of classification has been changed is there any noticeable break in the curves that might be attributed to a difference in method.

A further check has been applied to the topic of *Childhood and adolescence*. This topic was selected because of the relative objectivity of its terminology. The curve shows a decided upturn beginning about the year 1920 and continuing to the present time. The question is, whether this is in part an artifact of classification or



whether it represents an actual trend in psychological interest. In order to throw some light on this question, I have counted the number of titles not classified under this topic in which one or more of the following words occurred: child, boy, girl, infant, baby, adolescent or adolescence, childhood, infancy or babyhood, one-year-old, two-year-old, etc., up to seventeen years, new born when used as noun and referring to human beings and birth when context showed that infants were used as subjects. The names of school classes when used as a means of differentiating subjects were also counted for all levels below college. Plurals and foreign language synonyms were of course included. This count was taken for the 1900, 1910, 1920, 1925 and 1930 volumes.

The assumption was made that if the apparent increase in interest in this field was due to a different system of classification in the later years, that such a change would be shown by the occurrence from year to year of more titles within the class in question that lack these critical words and fewer titles containing such words in the remaining sections of the volume. This, however, was not found to be the case. Although the 1925 and 1930 volumes of the *Index* show a small and unreliable tendency to include more titles lacking the critical words under the heading of *Childhood and adolescence* than do the earlier volumes, the percentage of titles classified under other sections but containing one or more of these words is also greater in the later volumes than in the earlier ones. Neither difference is reliable and the two practically cancel each other.

*Summary.* Tabulation of the annual number of publications on certain specified topics as listed in the *Psychological Index* from 1894 to 1931, the *Psychological Abstracts* from 1927 to 1932 and comparison with the distribution of papers on these topics presented at the annual meetings of the American Psychological Association shows that a number of significant changes have taken place in the pattern of psychological activity during the past thirty-eight years.

1. The percentages based upon the *Psychological Abstracts* agree rather closely with those of the *Psychological Index* for each of the five years for which the comparison has been made. The proportionate representation of the different topics among the papers read at the American Psychological Association bore a closer resemblance to the corresponding percentages from the *Index* during the pre-war period than it has in the post-war period. This suggests that American psychology is tending to break away from its European traditions and to develop a pattern of its own.



2. Except for a temporary revival of interest immediately after the war, publications on *Sensation and perception* have not kept pace with the increasing size of the annual volumes of the *Psychological Index*. Although the absolute number of titles has shown little change, the topic now comprises only a third as great a percentage of the total volume as it did in the '90s. At the Association meetings, however, the percentage of papers on this topic has increased during recent years.

3. The curve for *Educational psychology* based on the *Index* rises fairly steadily throughout the entire period, but at the Psychological Association meetings, the proportionate number of papers on this topic shows an initial rise to a maximum in 1916 and a decrease thereafter.

4. Papers on *Industrial and personnel problems* form a negligible proportion of the total from both sources up to the beginning of the war. At the Association meetings the acme of interest in this topic was reached shortly after the war but the papers listed in the *Index* have continued to increase slightly both in absolute and in relative frequency up to the present time.

5. In the *Psychological Index*, papers on the *Nervous system* show a decrease both in absolute frequency and in the proportion of the entire volume comprised under this head. At the Association meetings, only occasional papers on this topic have been presented during any period since its organization.

6. *Plant and animal behavior* first becomes an important classification of the *Index* about the year 1906. From then on, papers on this topic increase both in absolute and relative frequency until 1914. Since then there has been, on the average, a small increase in the absolute number of annual publications on this topic but the increase has not been as great as that for psychology as a whole. At the Psychological Association, the papers on this topic show two distinct waves of interest; an earlier one which coincides fairly closely with that shown in the *Index* although the maximum is reached a little earlier, and a later one which begins about the year 1922 and has continued to the present time.

7. The growth of interest in *Childhood and Adolescence* has been very marked since 1920. The percentages from the two sources (*Index* and Association papers) correspond fairly closely, considering the comparatively small number of the latter, indicating that the subject has attracted about the same amount of psychological activity in this country and abroad.



8. Both sources show a very marked access of interest in *Mental tests* from about 1914 to 1925 but this interest appears to have been far greater in America than in other countries. Since 1925 the apparent interest in mental testing as such has been much less, but it is likely that for the most part this is to be attributed to the fact that testing has become a rather generally accepted method to be used in connection with other types of psychological investigation. Its usefulness as a method has been sufficiently well established to make it unnecessary to spend a great deal of further time in "testing the tests."

9. Papers dealing with questions of *Statistical method* make up a small proportion of the total from both sources but have shown a steady increase in frequency during late years.

10. The following topics have maintained a fairly constant position with reference to the total over the 38 year period: *Attention, Memory and thought, Work and fatigue, Sleep and dreams, Feeling and emotion, Maldevelopment and mental deficiencies.*

11. The use of philosophical terms in the titles of papers shows a very marked decrement during the decade from 1910 to 1920.



## EXPERIMENTAL STUDY OF READING

BY MILES A. TINKER

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The investigations which are covered in this review may be grouped as follows: (1) legibility of print; (2) visual apprehension;<sup>1</sup> (3) perception and eye movements in reading. For the most part the studies considered succeed those which were reviewed in the preceding papers of this series (38, 39, 45). No publications appearing later than April, 1932, are included.

Bibliographies, summaries of part of the field, textbook surveys, discussions and comments, and reprinting of material that has appeared earlier will be found in references 2, 3, 4, 12, 13, 20, 21, 24, 27, 38, 39, 44, 45, 54. Several new devices or modifications of previous apparatus have been constructed for use in reading investigations. These are described in references 1, 11, 23, 41, 43, 52. Precautions in methodology are discussed in 29.

### LEGIBILITY OF PRINT

The legibility of advertising copy has become an increasingly important problem during recent years with the ever growing use of colored printing. Experimental evidence on the changes in legibility accompanying variations in color of print in a normal reading situation is presented by Tinker and Paterson (47). Employing speed of reading as a measure of legibility and eleven combinations of colored ink and paper they discovered that the combinations providing (1) good legibility were black on white, green on white, blue on white, and black on yellow; (2) fair legibility were red on yellow, and red on white; (3) poor legibility were green on red, orange on black, orange on white, red on green, and black on purple. From this evidence they formulated the rule: "In combining colors (color of ink and paper) care must be taken to produce a *printed page* which shows a maximum of *brightness contrast* between print and background." While the above order of legibility might not hold in a

<sup>1</sup> Experiments on visual apprehension will be included since the span of apprehension for certain types of material appears to be intimately related to perception in reading.



situation where both letters and background are printed upon white paper with different colored inks, the conclusions concerning the importance of brightness contrast is applicable to both kinds of printing. In another study, and with the same color combinations used by Tinker and Paterson, Preston, Schwankl and Tinker (31) measured legibility by determining the farthest distance from the eyes at which five-letter words could be read accurately. The obtained order of relative legibility of the color combinations is approximately the same as that obtained in the previous study as is shown by the correlation coefficient of  $+.864$  between the two orders. The most marked discrepancy in the two investigations is in the rank of black on white which is 1 (most legible) in the speed of reading experiment and 4 in the distance-perception study. The fact that Luckiesh (45) also found several color combinations more legible than black on white suggests that there is a true difference between the relative legibility of black on white in the normal reading situation and when read at a distance. Employing a distance method, and similar color combinations Sumner (34) arrives at approximately the same conclusions as the above writers concerning the legibility of colored printing. He discovered in addition a correlation of  $+.54$  between order of legibility and preference for the combinations used.

The apprehension of colored letters was found by Tinker (48) to be influenced to a considerable degree by the brightness contrast between symbol to be apprehended and its background. The results will be discussed further under "visual apprehension." Miyake, Dunlap, and Cureton (25) measured the relative legibility of colored (including black and white) numerals on (1) colored and (2) a black background by noting the number of times each combination was read correctly during a very brief exposure. The rank orders of relative legibility show that in general, as the luminosity difference between printed numerals and background decreased, the legibility of the color combination decreased.

A series of reports have been concerned with the influence of brightness contrast between symbol and background on perception of achromatic stimuli. In a carefully worked out series of experiments Ferree and Rand (16) measured the speed of vision in perceiving dark objects on light backgrounds and light objects on dark backgrounds by determining the shortest exposure during which a symbol could be distinguished accurately. Broken circles subtending visual angles of 1 to 3 minutes were used as test objects. Eleven degrees of illumination intensity varying from 1.25 to 100 foot-candles were



employed. The four combinations of brightness used in constructing the test objects were black on white, white on black, white on gray, and black on gray. Almost without exception the rank orders of brightness combinations for speed of vision (*i.e.*, relative legibility) were found to be white on black most legible, black on white next, white on gray next, and black on gray poorest. This rank order corresponds exactly with the degree of luminosity difference between symbols and backgrounds under the conditions of their experiment. In a later report Ferree and Rand (17) have amplified their discussion of the above findings. Employing a somewhat different technique Taylor and Tinker (36) also found that the greater the luminosity between symbol and background, the higher the accuracy of apprehension.

Although the experiments just discussed do not involve a normal reading situation it was possible to maintain normal reading conditions in another study concerned with approximately the same problem. Paterson and Tinker (30), using the two equivalent forms of the Chapman-Cook Speed of Reading Tests with 280 subjects, compared the speed of reading black print on white background with white print on black background. They found a 10.5 per cent difference in favor of the black on white printing arrangement. In another investigation Holmes (22), employing as a measure of legibility the distance from the eye at which a symbol could be read correctly, compared the perceptibility of isolated words printed in black type on white background with words printed in white type on black background. (In both of these studies the white printing was achieved by printing the black background from zinc etchings so that the white letters were produced by the enamel paper showing through as white outlines.) A 14.7 per cent advantage was found for black type on a white background. A consideration of all related studies suggests that factors other than brightness contrast are involved as determinants of apprehension in perceiving printed words and other symbols, especially in approximately normal reading situations. In a study now in progress at Minnesota an analysis of several factors which may influence the perceptibility of black and white print is being made.

In another part of their study of intensity of light and speed of vision, Ferree and Rand (15) investigated the effect of size of object and difference of coefficient of reflection as between object and background. They discovered (1) that increasing size of visual symbol greatly increased its legibility under all degrees of illumination, and



(2) that the effects of increasing the difference in coefficient of reflection (luminosity) between object and background were very similar to those of increasing size of object.

Several other aspects of legibility have received attention. In another of their studies of typographical factors influencing speed of reading Tinker and Paterson (46) investigated the effect of simultaneous variation of type size and line length. The speeds of reading text, printed line for line in 6, 8, 10, 12, and 14 point type were compared. Text in 8 point type with 17 pica line length, and in 10 point with 19 pica line length were read fastest and both at approximately the same rate. Still smaller type with shorter lines and the larger type with longer lines were read slower. Evidently both type size and line length must be properly balanced (with other factors not yet investigated) to produce a printed page of maximum legibility.

After pointing out the lack of conclusive evidence concerning optimum length of line for children's books, Gates (18) presents evidence which indicates that the line length (either short or long) to which the child has become accustomed produces fastest reading. Employing first grade children, speeds of reading test material in short, medium, and long lines were compared. For the experimental group accustomed to reading lines of various length, one length was about as good as another. Where children (control group) had read text principally in one length of line, however, that length produced a greater speed of reading. While these results may not be applied to adult reading, it is obvious that optimum line lengths should not be recommended without sufficient proof that they are optimum.

An unsuccessful attempt has been made by Buckingham (5) to discover which of several typographical arrangements is best for children's texts. The law of the single variable in its traditional sense was rejected in favor of simultaneous variation of several typographical factors. Twelve, 14 and 18 point type; 3, 4 and 5 point leading; and  $14\frac{1}{2}$ , 21 and 24 pica line lengths were combined in various ways to form 18 typographical arrangements of textual material. Twelve point type in either a short or medium length line and with 3 or 4 points leading respectively appeared to produce fastest reading. Buckingham's results are of no value either to the printer or to the educator for the following reasons: (1) the selections employed were not satisfactorily equated for difficulty according to the sequence in which they were to be read; (2) no account was taken of sampling errors which are apt to be large in short samples of reading performance; and (3) no measures of dispersion of scores



or significance of differences between averages are given. Considering both the uncontrolled nature of the experiment and the method of presenting results one cannot be sure that even the largest differences obtained are significant. Indeed, it is questionable to assume that variations in typographical arrangement within rather wide limits produces constant differences in reading performance at any age level at which reading habits have not become stable.

Although Tinker (40) found that Old Style was somewhat more legible (distance method) than Modern numerals when in isolation, and much more legible when printed in groups, the Modern numerals were read under ordinary reading conditions just as fast and just as accurately as Old Style. It is suggested that extensive reading may lead to greater ocular fatigue with Modern numerals because their perceptibility is poorer.

To increase the ease of finding German words in German-English dictionaries and similar word-lists Taylor (37) suggests that all syllables or even letters common to a series of words (as *schmelz*-of *schmelzarbeit*, *schmelzbar*, etc.) be omitted after they have once been given. In mathematical tables of the present day common figures are eliminated to facilitate the finding of numbers. It is desirable to have experimental evidence on this and other factors which may effect the legibility of tabular material and word lists for usually it is not safe to infer the most legible typographical arrangement.

Turner's (51) results showed that manuscript writing has a significant margin of superiority in legibility in comparison with cursive writing. This margin appears to be due to the independence of the letters, good spacing between words, and economy in line space. This finding has important implications for teaching of writing since production of manuscript writing is faster than cursive writing in most elementary grades.

Earlier results are confirmed by Tu (50) who found that Chinese characters were read more rapidly in the vertical than in the horizontal arrangement. Geometric figures, however, were read faster in the horizontal by both Chinese and Americans. Apparently the most efficient typographical arrangement for Chinese readers is largely determined by past reading experience.

Ostwald (28), having noted that there appears to be no orderly plan of determining the size of a printed page for various kinds of subject matter, suggests that each succeeding smaller size of page may be produced by halving the larger sheet; that the different sizes be similar to each other geometrically; and that the two sides of a



page always have the ratio  $1:\sqrt{2}$ . Such strict uniformity is probably not practical although few would deny that there is room for improvement in methods of deciding the best size for a printed page.

To determine their usefulness as test objects of visual acuity, Gnad (19) determined the relative legibility of numerals and capital letters. ACLDVOU714 were most easily recognized; TPZIGEFKNWR623 were of medium legibility; and HMYXSQB389 of poor legibility. The Snellen E-Test was probably more legible than any of the letters or numbers. An analysis indicated that legibility depended upon (1) visual angle subtended by strokes in test object, (2) distribution of black and white in symbol, (3) characteristic form of symbol, (4) symmetrical distribution of space in objects, and (5) simplicity of form.

#### VISUAL APPREHENSION

As part of a more extensive investigation on visual apprehension, Tinker (48) determined the influence on perceptual span of three methods of scoring responses in which accuracy of position in the series as well as correctness of reproduced symbols were considered. In general, it was found that absolute span of visual apprehension changed significantly from one scoring method to another, but size of span in relation to others in the group (relative span) showed little variation with change in scoring method. All methods of scoring had high internal consistency.

In the same investigation Tinker analyzed the influence of letter position on visual apprehension of series of eight letters each and found a definite effect. From left to right there was a decrease in the average number of letters correctly reproduced in each succeeding letter position through the seventh and then a slight increase in the last position. The decrease from the first to the fourth was constant and gradual. There were rapid drops in score from the fourth to fifth and sixth to seventh positions, and always an increase at the eighth position. These produced marked irregularities in the consistency of trend from position to position in the series. Both absolute and relative variability of scores increased consistently from letter position one through eight.

In general, Crosland's (9) findings for influence of letter position on apprehension agree with Tinker's (48). A decrease in score occurred in each letter position until the end position which showed a slight increase. Crosland employed letter series of various lengths (4 through 9). The curves of average scores at each letter position



for series of 6, 7, 8, and 9 letters, which had few or no entirely correct series, approximated each other closely, but the curve for the 4-letter series is well separated from the others. This was due apparently to the fact that the 4-letter series had 52.1 per cent of correct responses in all 4 positions simultaneously (whole series correct). When only series with one or more errors were included, the curves for all series (4 to 9 letters each) coincide closely (Figure a). Crosland's results (1) confirm Tinker's (48) contention that the most adequate measure for influence of letter position is obtained by using a letter series which is just longer than the span of the subjects, and (2) supports the reviewer's previous suggestion (39) that a high per cent of correct responses for short series tends to influence the shape of the composite curve (showing score in each succeeding letter position) when scores for series of various lengths are averaged all together.

Tinker (48) has studied the influence of color on visual apprehension for (1) homogeneous colored series, and (2) heterogeneous colored series of letters. With the homogeneous colored series there was no relation between span of apprehension and either color preference or attention value of the colors. There was a slight relation to luminosity, however, for in general, the smaller the luminosity difference between letter and background, the less the span. With heterogeneous colored letters there was no relation between apprehension score and color preference, but an appreciable relation between score and both attention value and luminosity of the colors. No marked sex differences appeared. In comparing spans for homogeneous with spans for heterogeneous colored letters it was found that the former were always larger. Employing black, dark gray, and light gray letters in homogeneous and heterogeneous series, Taylor and Tinker (36) discovered that the amount of luminosity contrast between stimulus and background was an important determinant of visual apprehension. As the result of an analysis to discover some of the factors influencing visual apprehension of chromatic and achromatic stimuli Tinker (48) states: "Both direct and indirect evidence from a number of related investigations warrant the following conclusions concerning comparative potency of hue and luminosity of color on visual apprehension and perception of symbols: (a) Hue of color has little or no effect on apprehension and perception. (b) The luminosity contrast between symbol to be apprehended and its background has a large and very important influence on apprehension and perception. (c) Lag of visual sensation, which is due



to brightness contrast between symbol and background, probably explains to a large degree the differences obtained in visual apprehension and perception of symbols varying in color and luminosity."

In a comparative study of visual apprehension in nursery school children and adults Taylor (35) obtained a span of 1.92 items for the children and 6.17 for adults. Inanimate objects were more readily apprehended by adults, and animate objects by children. For the children, size of apprehension score was closely associated with both chronological and mental age.

#### PERCEPTION AND EYE MOVEMENTS IN READING

On applying Huey's technique to the reading of Chinese Chou (7) found, as Huey had for reading English, that left and upper halves of Chinese characters are more suggestive of the whole-characters than either right or lower halves. This is probably due to the fact that radicals are on the top or the left, and the characters are mostly written from these directions. In a second report Chou (8) shows that Americans were able to judge true positions of Chinese characters with a fair degree of accuracy, and that most of the errors committed were reversals.

Davidson (10) employed massed forms as an aid in teaching four-year-old (M.A.) children to read. These massed forms duplicated actual word forms and served to generate interest, train discrimination, and improve the use of cues in word perception. There appeared to be a definite transfer to the real reading situation.

Errors made in learning mirror reading were utilized by Tinker and Goodenough (42) to study certain factors influencing word perception. Analysis of errors yielded results similar to those of certain earlier studies: (1) initial letters were of more importance for word perception than either final or intermediate letters; (2) context was frequently utilized to good advantage in apprehending difficult words; and (3) word-length was an important determinant of word form.

Tinker (49) shows that although capital letters are more easily perceived than lower-case letters of the same point size, total word form is more potent in the perception of words in lower-case than in all capitals where perception seems to occur largely by letters. This probably explains the faster reading of text in lower-case type.

Downey's (14) analysis of errors of perception on brief exposure of sentences with many typographical errors showed the three most important types of errors to be (1) supplying omitted letters,



(2) letter substitution, and (3) word substitution. This tendency to proof-readers' illusion appeared to correlate to a considerable degree with intelligence.

In her report of a carefully planned eye movement experiment Vernon (55) points out the chief characteristics of proof-reading in comparison with normal reading. In ordinary reading, reading time, and frequency and duration of pauses were very similar for the two kinds of readers (normal and proof-readers). The variability of reading performance and number of regressions were considerably less for proof-readers than for the controls. In reading material with misprints, however, the reading time and number of regressions increased much less and then remained more constant for proof-readers than for the other subjects. Vernon concludes that this was due to the fact that the proof-readers were able to adopt and maintain indefinitely a more efficient attitude or mental set towards each type of reading material than the normal readers.

In another study Vernon (53) reaches some important conclusions concerning the influence of motor ability of the eyes, and interest and affective reactions on eye movements in reading. Steadiness and accuracy of voluntary fixation and accuracy of voluntary movements appeared to be associated with relatively few fixations and regressions in reading. Lack of attention to meaning led to the most rapid reading and most regular eye movements. With difficulty in comprehension and either high personal interest or strong affective reactions to the printed material the reading was slow and eye movements revealed marked irregularities. Since Vernon employed very few and highly selected subjects these interesting and suggestive results should be accepted as tentative.

According to Butsch (6) fixations of the eye in typing are much more frequent and longer than in ordinary reading. Rapid typists, however, use fewer pauses than slow writers. The eye-hand span was found to vary directly with speed of typewriting, ranging from zero to 13 letter spaces. Most typists tended to keep the eye about 1 to 1½ words ahead of the hand so that there was about one second between seeing a letter and writing it. There was little evidence, even for expert typists, that writing is frequently done by phrases. "Apparently during typewriting the eye does not read at all at its maximum pace or even at the rate which is determined by the requirements of comprehension, but instead reads only rapidly enough to supply the copy to the hand as it is needed."

Rebert (33) photographed eye movements of subjects as they



read chemistry, algebra and physics formulas in context. The formulas were read with unitary fixations (*i.e.*, as words) only when they were quite familiar, very simple and merely contributed to an understanding of the context. In general, formulas tended to be read in an analytical manner and in detail, especially when the context directed attention to relationships between characters of the formulas. This held for both naïve and experienced (with formulas) subjects. The fact that the experienced subjects used slightly fewer pauses and regressions than the naïve subjects in reading formulas has little meaning since Rebert's groups were small. Longer pauses and relatively more fixations and regressions were employed to read the formulas than the context. Rebert's concluding statement that "familiar chemical formulas tend to be read as units in the same manner as words are read although analytical readings occur" may be somewhat misleading since only the simplest of such formulas, as HCl, were read with single fixations.

In another photographic study of the reading of familiar numerals, Rebert (32) found that, in general, the numerals tended to be read in the same manner as words of the context although in several cases detailed readings involving two or more fixations on the numerals occurred, especially with the numeral 3.1416. Pauses on numerals were longer than on words of the context.

Murray (26) photographed the eye movements of stutterers and normal individuals while they read hard prose, poetry, and light prose. Since there were only 18 subjects in each group the conclusions based on group comparisons can be only tentative. The stutterers used more fixations and regressions, a longer perception time, but shorter pauses than the normal readers. The author's comparison of his results with those of Buswell has no validity whatever since (1) the former use typewritten and the latter printed copy, and (2) the reading material and the length of line in the two studies were different. In his qualitative analysis Murray identifies six eye movement patterns which were classified according to presence and position of regressions in reading a line of print. A similar classification was made for pause duration. The results of the author's comparison of stutterers and normal readers by means of these classifications may be stated in simpler terms by merely saying that the stutterers manifested greater irregularity in sequence of fixations and in pause duration than normal readers.

As part of a more elaborate study of reading Davidson (10) photographed the eye movements of a child three years and seven



months old and found the records superior to those of ordinary children in the third grade.

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# CONDITIONED WITHDRAWAL RESPONSES WITH SHOCK AS THE CONDITIONING STIMULUS IN ADULT HUMAN SUBJECTS

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The conditioned withdrawal response with electric shock as the conditioning stimulus has been both the high hope and the utter despair of C-R experimenters and writers. On the one hand, both Bekhterev (3-11) and Watson (44) offered it as *the* method for the study of capacity and behavior modifiability of organisms in both ontogeny and phylogeny. The method, it was pointed out by behaviorists and reflexologists, is not only objective and quantitative, translating psychological categories into physical c.g.s. units but, because of the universality of the response of organisms to electric shock, affords a ready comparison between the capacities and behavior modifiabilities of vertebrate and invertebrate, animal and human, child and adult, normal and abnormal. This optimistic contention of the omnipotence of the shock C-R has been little modified even after later experiments would indicate it to be at best highly overstated. On the other hand, as a result of some disappointing experiments on human conditioning with shock, a number of C-R experimenters and writers have fallen into—what may be called—uncritical pessimism as to the general value of the C-R as a method and an explanatory principle in psychology. It is argued by these writers that since a number of human subjects cannot be conditioned to shock after hundreds and even thousands of trials, how is learning ever possible in terms of conditioning (19, p. 290, footnote 4); that since a number of subjects give the shock C-R only sporadically, C-Rs are only the “false reactions” of ordinary reaction time experiments (47); that since the C-R is apparently affected by what is traditionally identified as “attention,” “consciousness,” and the like, its very existence is dependent upon these factors (18). As this controversy seems to be not only a matter of interpretation but also a result of a lack of thorough acquaintance with the experimental literature, this review hopes, among other things, to be of aid in making the topic less controversial.



The review is confined to experiments on withdrawal C-Rs to shock, not treating respiratory and galvanic changes. It includes only experiments with adult human subjects, experiments with children and with animals other than dogs having been reviewed elsewhere (*Archives of Psychology*, 1933, No. 148; *PSYCHOLOGICAL BULLETIN*, 1933, 30, 261-324), while a summary of the results of shock conditionings of dogs is being prepared for a forthcoming publication. Of the 33 experiments treated here, 11 are from American laboratories, one from India, one from France, and the remaining 20 from Russian, more exactly from Bekhterev's laboratories. For convenience the entire material reviewed is divided into: I. Earlier Experiments from Bekhterev's Laboratory; II. Later Experiments from Bekhterev's Laboratory; III. Experiments from Other Laboratories; IV. Discussion. The Later Experiments from Bekhterev's Laboratory are divided topically into: *Experiments with Abnormal Subjects*, *Experiments on the Effect of Extraneous Factors on the C-R*, and *Miscellaneous Experiments*; the experiments in other sections are reviewed in chronological order.

#### I. EARLIER EXPERIMENTS FROM BEKHTEREV'S LABORATORY

*The Laboratory and Technique.* The general technique of the Bekhterev laboratory is well known, but its main features may bear repetition. Unlike the Pavlov and Krasnogorski laboratories for salivary conditioning, the Bekhterev laboratory for shock conditioning has been well controlled from the very first experiment (1909), with the experimenters isolated from the subjects' rooms, the stimuli delivered automatically, and the responses registered objectively. In the earlier experiments the shock was invariably the induced current in the secondary of the inductorium, the primary of which was connected to batteries of 2-6 volts and the distances between the coils of which had to be adjusted from subject to subject and from time to time. The electrodes were attached to the foot between the *capitula ossium metatarsium* and the *tuber calcanei*, and the responses were recorded on a kymograph or a polygraph by means of Marey tambours or electro-magnetic needles. The duration of the experimental sessions was about an hour each, the intervals between trials 10-15 seconds, and the number of trials in each session 100-150.

*Experiments.* Israelson (23) is the first experimenter to have established C-Rs in human subjects with electric shock as the conditioning stimulus (1909). Unfortunately, however, his extensive original report has not been made available for this review, which



has had recourse to only summaries of his investigation by himself as well as by his colleagues. The experimenter, who had been working on tactile C-Rs with shock in 3 dogs, was apparently interested in testing objectively the Weber sensation circles. He thus applied in his subjects a tactile stimulus to one hand and a warmth stimulus from a 25 c.p. electric lamp to the other hand, the 2 stimuli being presented simultaneously for one second before the applications of the shock. The C-R to the compound stimulus is reported to have been formed after respectively 220 and 420 trials in 2 subjects and to have become so stable as to be elicited for 100 trials without reinforcement; a C-R of the second order to an auditory stimulus upon the basis of the tactile is also reported. As to the test of Weber sensation circles, the experimenter states that he has formed tactile differential C-Rs within the diameter of 1.5 cm. on the forehead, 5.0 cm. on the thigh, and 2.5-3.0 cm. longitudinally and 3.0-4.0 cm. vertically on the wrist.

Molotkov (30) experimented with visual simple and differential C-Rs in 4 subjects nineteen, twenty-two, twenty-five, and forty-two years of age. The conditioned stimulus for the simple C-R was the flashing of an electric lamp of 1 c.p. through a frosted glass 4 cm. in diameter, the flash being given simultaneously with the shock in the 2 younger subjects but preceding the shock by 2 seconds in the 2 remaining subjects. The C-R first appeared in the first 2 subjects after 39 and 48 trials respectively and was elicited 2, 2, 5, and 10 times in succession after 250, 599, 630, 886 and 83, 163, 182, 228 trials respectively. In the remaining 2 subjects, in which the light preceded the shock by 2 seconds, it did not appear even after 230 and 1,260 trials respectively, which, however, does not warrant the experimenter's conclusion that C-Rs with such intervals cannot be formed. The C-Rs in the first 2 subjects were then unconditioned and a week later 2 new C-Rs to a change in illumination from 0.25 c.p. to 0.5 in one and to 0.12 in the other subject were formed after 58 and 22 trials respectively. These new C-Rs were now differentiated from changes in illumination of 0.25 to 0.12 and to 0.5 c.p. by the method of contrasts after 411 and 324 trials respectively, using about equal ratios of positive and negative applications. Finally, C-Rs to colored lamps—yellow, red, and blue—of 0.3 c.p. were formed in 3 subjects after 30, 23, and 35 trials respectively (the last subject could not previously form a C-R to a white light of 1 c.p. preceding the shock by 2 seconds after 230 trials), and respectively



differentiated from red, yellow, and red lights of the same illumination after 16, 13, and 14 days of experimentation.

Grecker (17) investigated the formation of tactile C-Rs in 4 normal and 2 katatonic subjects but apparently found no differences between the two groups either in speed of formation of the C-R or in stability of the response or even in the threshold to shock. The 4 normal subjects first formed the C-R after 7, 17, 281 and 1,340 trials respectively and the 2 katatonics after 42 and 210 trials, while after a number of experimental days the response became stable—could be elicited 10 times in succession—in both groups alike. The formation of olfactory C-Rs to oil of cloves after 57 trials, to camphor after 46 and to asafoetida after 28 trials is said to have been obtained by Bondireva (13), but the reviewer was unable to examine her original report.

A very extensive experiment on simultaneous visual and auditory conditioning in 5 subjects, twenty-one to thirty-five years of age, was performed by Platonov (34). The visual stimulus was throughout the experiment the flashing through a frosted glass of 2 electric lamps of 10 c.p. each, while the auditory stimulus was the sound of middle "g" on a zither for 2 subjects and the sound of an electric bell for the remaining 3 subjects. Both stimuli as well as the shock were given simultaneously, the bell and light lasting for 1 and the note on the zither for 10 seconds. The C-R appeared in the different subjects after 5, 29, 32, 117, and 413 trials respectively, becoming after some training so stable that it was elicited for hundreds of trials in 3–20 successive days without reinforcement; indeed, after some training reinforcement decreased the frequency of the occurrence of the C-R.<sup>1</sup> The C-R was elicited not only by the combination of the auditory and visual stimuli but also by each component alone, although the incidence of the C-R to the 2 stimuli was greater than that to the auditory, which in turn was greater than that to the visual stimulus, the difference between incidences becoming more pronounced with training.

To illustrate more clearly the development of simple C-Rs with shock in adult human subjects, it seems to be worth while to present the results of 2 subjects in detail. Subject I was a male twenty-one years old. His threshold was 4.5 cm. distance between coils, and he

<sup>1</sup> The fact that in human subjects reinforcement may decrease the incidence of the C-R and the need of optimum distributions and, after some training, only occasional applications of shock, is little known or heeded by a number of experimenters.



responded to the shock with only the stimulated foot. The C-R first appeared after 413 trials on the fourth experimental day, and after 452 trials in the same day was given 5 times in succession. On the fifth day there were given 61 reinforcements with the shock—and 15 out of 27 trials of light plus sound, 6 of 9 trials with the sound alone, and 2 of 3 trials with light alone were followed by the C-R. In experimental days V–VII, however, the C-R became very unstable, appearing only once or twice in succession, while during days VII–XI it did not appear even once. Towards the end of the XIIth experimental day the experimenter, who suspected that the instability was due to too many and too frequent shocks, began to present the conditioned stimuli without reinforcements, and as a result 20 of 28 non-reinforced trials were followed by the C-R as compared with 25 of 56 in the first part of the session when 35 reinforcements were given. Beginning with the XIIIth and up to the last, the XXth, day no shock was applied. Still the percentage of incidence of the C-R on successive days to the 2 stimuli together were: 65, 75.5, 90, 87, 96, 96, 90, 52, with corresponding percentage incidences to the sound alone of 58, 61, 47, 59, 46, 38, 25, 15, and 5.6, 0, 7.5, 7.3, 0, 0, 0, 0, to the light alone.

Subject II was a female twenty-two years old. She responded to the shock with both feet and had a shock threshold at 7 cm. distance between coils. The C-R first appeared after 29 combinations with the shock on the first experimental day, during which it was elicited 23 of 27 times by the compound stimulus, 20 of 28 times by the sound alone and 19 of 36 times by the light alone. The second day only one reinforcement was made at the beginning of the experiment, and the percentage incidence of the C-R was 100 for the compound stimulus, 98 for the sound alone, and 78 for the light alone. Experimental days III–VII showed 100 per cent incidence to all conditioned stimuli with only one reinforcement at the beginning of each day, while the percentage of incidence for the eighth day with no reinforcements was 100 for the light plus the sound and for the sound alone, and 85 for light alone. After a recess of 3 weeks, 6 more days were tried with no reinforcements, and still the C-R was 100 per cent in response to the compound stimulus, with 100, 100, 100, 100, 71, 100 to the sound alone and 70, 62, 62, 35, 57, 47 to the light alone. Another recess of 20 days was then made, after which 16 more experimental days were used. The incidence of the C-R to the compound stimulus was now 100 per cent the first fourteen days, 50 per cent the fifteenth and 0 the sixteenth or last day. The percentage



of incidence of the C-R to the sound alone was 72, 80, 76, 52, 58, 90, 84, 76, 43, 46, 57, 12, 6, and 0, 0, 0, while the per cent occurrence of the C-R to the light alone was 42, 25, 20, 13, 43, 51, 35, 33, 25, 21, 28, 1.6, 0, 0, 0, 0. It should also be added that beginning with the eleventh day of this series the subject began to respond only with the stimulated foot instead of with both feet as usual.

Shevalev (41) worked on tactile differential C-Rs in 2 subjects, associating definite points, marked with dye, on their bodies with shock and differentiating other points by the method of contrasts. The experiment was begun on March 12th with one subject, the first positive point being 6 cm. to the right of the spinal cord and on the level with the transverse process of the ninth thoracic vertebra. The C-R appeared after 15 trials, but no stable differentiation was developed in spite of a month of experimentation. After summer vacation the experiment was resumed, the C-R appeared 4 times in succession after one reinforcement, and on January 27th of the next year the differential C-R is reported to have been within a diameter of 4 cm., but 2 days later the differentiation was lost. January 31st another positive point was chosen to the left of the spinal cord with the exact location of 27 cm. above the olecranon, 14.5 cm. exterior to the distal end of the spine of the scapula, and 14.5 cm. below the acromial end of the clavicle. The C-R first appeared on the second trial and became quickly differentiated to a few cms. but again the differentiated area was unstable. In subject II the positive spot was 11 cm. below the transverse process of the seventh cervical vertebra and 6 cm. to the left of the spinal cord. The C-R appeared on the 47th trial but then disappeared and did not reappear until after a few days. After 3 months of experimentation by the method of contrasts a differential tactile C-R of 4-6 cm. was produced for a while, but, as in the first subject, the differentiation was unstable.

A very interesting and extensive investigation of simple and differential conditioning as well as of unconditioning and interactions between various C-Rs was made by Chmikhov (15) on 6 subjects—3 males and 3 females—twenty to twenty-nine years of age. The procedure of the investigation was as follows: First, a C-R, with an electric shock applied to the right foot, was formed, well stabilized, and differentiated from similar stimuli. Then, a C-R, with a stimulus of a different modality and with shock applied to the left foot, was formed, stabilized, and differentiated in the same subject. Next, the 2 conditioned stimuli were presented to the subjects, at first in alternate series and later simultaneously. Finally, the C-Rs were



unconditioned. The conditioned stimuli in 3 subjects for the first C-Rs were electric lamps of 25 c.p. and for the second C-Rs electric bells, while for the 3 remaining subjects the order was reversed. The stimuli to be differentiated were colored lights and white lights of 5, 15, 25, 30, and 40 c.p. as well as the sounds of cymbals, a zither, and bells of different intensities. Both conditioned and conditioning stimuli were always given simultaneously and lasted for one-half of a second.

TABLE I  
THE FORMATION, DIFFERENTIATION, AND UNCONDITIONING OF VISUAL  
AND AUDITORY C-Rs WITH ELECTRIC SHOCK AS THE CONDITIONING  
STIMULUS IN 6 HUMAN ADULT SUBJECTS

	Subjects*					
	1	2	3	4	5	6
Sex and age of subject	M; 21 y.	M; 20 y.	F; 24 y.	F; 27 y.	F; 29 y.	M; 24 y.
Total days of experimentation	27	36	24	29	27	31
Total trials given	3820	5336	3665	4230	3800	4290
Distance between coils in cms.	5	4	5	5.5	5.5	0
Conditioned stimulus for first C-R	Light	Light	Light	Bell	Bell	Bell
Trials before appearance of first C-R	180	353	470	175	75	190
Trials before final stabilization of first C-R	320	530	1360	200	375	475
Days spent in formation and stabilization of first C-R	1-6	1-11	1-10	1-3	1-10	1-6
Days spent in differentiating first C-R	7-11	12-17	11-15	4-6	11-13	7-9
Conditioned stimulus for second C-R	Bell	Bell	Bell	Light	Light	Light
Trials before appearance of second C-R	10	30	70	320	230	550



TABLE I  
(Continued)THE FORMATION, DIFFERENTIATION, AND UNCONDITIONING OF VISUAL  
AND AUDITORY C-Rs WITH ELECTRIC SHOCK AS THE CONDITIONING  
STIMULUS IN 6 HUMAN ADULT SUBJECTS

	Subjects					
	1	2	3	4	5	6
Trials before final stabilization of second C-R	40	100	115	560	525	780
Days spent in formation and stabilization of second C-R	12-13	18-20	16-17	7-14	14-19	10-20
Days spent in differentiation of second C-R	14-16	21-25	18-19	15-19	20-22	21-24
Days spent in experimentation with applying the 2 stimuli alternately	17-20	26-30	20-21	20-22	23-25	25-27
Days spent in experimentation with applying the 2 stimuli simultaneously	20-24	31-33	22-23	23-24	26	28-29
Day on which C-R became unconditioned	27	36	24	29	27	31

\*One subject could not form a stable C-R even after 2 months of experimentation.

The results are presented in Table I, to which the following may be added. The stability of both the simple and the differential C-Rs became with training nearly 100 per cent in all cases <sup>2</sup> and no further reinforcements were applied after the 2 C-Rs had become stabilized and differentiated. When the 2 conditioned stimuli were presented in alternate series, each stimulus elicited its expected response except that at first, when the number of stimulations in each series was

<sup>2</sup> It must not be understood that all subjects in Bekhterev's laboratory form such stable C-Rs. It seems that in these earlier experiments subjects who did not condition well were given up and, as a rule, not even mentioned in the reports.



equal, the first stimulus of a series evoked the response of the preceding series; when the 2 conditioned stimuli were applied simultaneously, both feet responded.

## II. LATER EXPERIMENTS FROM BEKHTEREV'S LABORATORY

*The Laboratory and Technique.* The laboratory and technique of the later experiments differ in some respects from those of the

TABLE II  
FORMATION OF VISUAL SIMPLE AND DIFFERENTIAL C-Rs  
WITH SHOCK IN 6 SUBNORMAL SUBJECTS

	Subjects					
	1	2	3	4	5	6
Age of subjects	32 y.	24 y.	23 y.	36 y.	19 y.	19 y.
Diagnosis	Imbecile	Idiot	Feeble-minded	Idiot	Imbecile	Imbecile
Kind of conditioned stimulus	Red lamp	Blue lamp	Yellow lamp	Yellow lamp	Blue lamp	Yellow lamp
Trials before appearance of C-R	6	2	10	8	12	2
Maximum percentage of incidence of simple C-R in a session	85	100	92	54	44	100
Average percentage of incidence of simple C-R	47	68	41	46	31	50
Maximum percentage of correct differential C-R to color in a session	62	37	Not formed	Not formed Consistently		63
Average percentage of correct differential C-R to color	42	18	Not formed			43
Maximum percentage of correct differential C-R to location in a session	62	47	63			85
Average percentage of correct differential C-R to location	47	28	49			67



earlier experiments. The shock is nearly always applied to the hand instead of to the foot and is sometimes the house current controlled by various adjustable rheostats. The responses are often recorded not on a kymograph or a polygraph but in units on a reflexometer—or special manometer—scale, while in less quantitative investigations the subjects' responses merely flash a lamp in the experimenter's room. The experimental sessions are usually only about half an hour each, the intervals between trials 15–45 seconds, and the number of trials per session about 20–60.

*Experiments with Abnormal Subjects.* Lukina and Schniermann (27) studied the formation of simple and differential C-Rs in 6 oligophrenics, with whom a total number of 5,000 trials was made. The conditioned stimulus was the flash of a colored lamp which had to be differentiated from lamps of other colors or from lamps of the same color but in different locations. The results are presented in Table II, from which it may be seen that subnormals form C-Rs with shock rather readily, a finding in line with some other studies and with the negative correlations between speed of shock conditioning

TABLE III  
FORMATION OF A C-R WITH SHOCK IN 8 EPILEPTIC SUBJECTS,  
19-26 YEARS OF AGE.

Subject	Age of Subject	Total Number of Experimental Sessions	Total Number of Trials	Number of C-Rs	Trials before First Appearance of C-R
1	20 y.	14	741	137	7
2	26 "	14	734	58	Not given
3	21 "	21	1175	367	19
4	20 "	7	180	Not given	12
5	20 "	7	202	9	Not given
6	25 "	7	208	Not given C-R stable	1
7	19 "	10	486	295	11
8	21 "	11	576	8	Not given



and intelligence computed by the reviewer from the data of Osipova (*Archives of Psychology*, 1933, No. 148).

In another experiment Lukina and Matusova (28) investigated the formation of visual C-Rs to a red light in epileptics, nineteen to twenty-six years of age. Eight subjects were used and 180-1,175 trials were made with each subject. The results are presented in Table III, from which the wide range in the incidence of the C-R is rather obvious.

Kantorovich and Lukina (24) attempted the formation of a simple C-R in 20 cases of progressive paralysis. The conditioned

TABLE IV  
THE FORMATION OF C-Rs WITH SHOCK AND THE EFFECT OF C-R  
THERAPY IN CHRONIC ALCOHOLICS.

Subject	Total Number of Experimental Sessions	Did Stable C-R Form?	Therapeutic Results (Alcoholism after Leaving Hospital)
1	11	Yes	No drinking for 20 months
2	6	No	Unknown
3	7	Yes	Returned drunk after 3 weeks
4	5	"	No drinking for 2 months
5	12	"	No drinking for 3 months
6	10	"	No drinking for 3 weeks
7	12	"	No drinking for 2 months
8	12	"	No drinking for 1 month
9	9	"	No drinking for 2 months
10	12	"	No drinking for 5½ months
11	8	"	No drinking for 1 month
12	6	No	Drunk the day leaving the hospital; returned in a few days
13	8	Yes	No drinking for 3 weeks
14	9	"	No drinking for 4 months
15	6	"	No drinking for 2½ months
16	9	"	Unknown
17	5	"	Unknown
18	7	"	No drinking for 2 months
19	18	No	Drunk the day leaving the hospital
20	8	Yes	No drinking for 3½ months
Control Subject	Therapeusis Used		Therapeutic Results (Alcoholism after Leaving Hospital)
1	Medication		Returned to hospital in 3 days
2	"		Drunk in 4 days
3	Hypnosis		No drinking for 2 weeks
4	Medication		Drunk in 10 days
5	"		Drunk the day leaving the hospital
6	"		No drinking for 3 weeks
7	Hypnosis		Returned drunk the next day
8	"		No drinking for 1½ months
9	Medication		Drunk in 3 days
10	"		Drunk in 10 days



stimulus was the flash of an electric lamp, and 81-700 trials, distributed over 1-15 experimental sessions, were made with each subject. However, the C-R appeared only sporadically and in only 7 subjects, 4 of the remaining 13 subjects not even giving the expected response to shock itself. In the 7 conditioned subjects the incidence of the C-R was also extremely low, being respectively 17 out of 330, 7 of 600, 2 of 260, 5 of 461, 15 of 411, 20 of 158, and 10 of 129 trials.

In another investigation (26) Kantorovich studied the interesting problem of reconditioning chronic alcoholics by means of shock. Twenty subjects were used and 5-18 experimental, or therapeutic, sessions were made with each subject; 10 control subjects who had been treated by hypnosis and medication were also used. The stimuli to be reconditioned were: the exposure of cards "vodka," "alcohol," "drunk," and the like; the exposure of various bottles of vodka, wine, and beer; the odor of burnt alcohol; the administration of 15-20 drops of alcohol. These stimuli—first the verbal-visual, then the visual, then the olfactory, and finally the gustatory-tactual—were associated with a strong shock to both hands, the subjects being told that they were being given electric treatments. Differential stimuli such as the exposure of neutral objects and cards "health," "work," "sober," "wholesome recreation," the odor of oil of cloves, and the administration of 15-20 drops of a physiological salt solution were also given from time to time. The differential stimuli were of course never associated with shock, while the alcoholic stimuli were always reinforced whether the C-R appeared or not. The results are presented in Table IV, from which it may be seen that 17 of the 20 patients formed stable C-Rs and that the C-R therapy was, as a rule, quite effective.

*Experiments on the Effects of Extraneous Factors of the C-R.* Oparina (32) studied the effect of one and of several applications of extra stimuli upon simple and differential C-Rs of 8 subjects. The extra stimuli were applied 2-3 seconds before the conditioned stimuli and continued for 2-3 seconds more together with the latter, the combination of the 2 stimuli being of course never reinforced by shock. The results are summarized descriptively in Table V, as the experimenter, although giving a few kymographic records, does not present her data quantitatively. The effect of extra auditory stimuli upon visual C-Rs was studied by Schniermann (37), who reports that noises—bells, sound of kymograph, rappings—impaired the differential C-Rs of his subjects but musical sounds improved them.



TABLE V  
THE EFFECT OF ONE AND OF SEVERAL APPLICATIONS OF EXTRA STIMULI UPON SIMPLE AND DIFFERENTIAL C-Rs WITH SHOCK IN 8 HUMAN ADULTS.

CONDITIONED WITHDRAWAL RESPONSES

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Subject	Conditioned Stimulus	Speed of Formation of Simple C-R	Characteristics of Differentiation	Effect of the Application of a Bell			Effect of the Application of Middle "c"			Effect of the Application of Lights		
				Once		Several Times	Once		Several Times	Once		Several Times
				All Stimuli Produced Strong Withdrawal Responses								
1	Red Light	Fast	Partial	Complete; quickly established	Differentia- tion to extra stimulus after 2 trials	Same	Same	Same	No	No	C-R of sec- ond order to extra stimulus after 4 trials	
2	Middle "c"	Fast				Same	Same	Same	No	No	C-R of sec- ond order	
3	Middle "c"	Slow	Partial	Withdrawal	C-R of sec- ond order	Same	Same	Same	No	No	C-R of sec- ond order	
4	Middle "c"	Slow	Complete; quickly established	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	No Effect	
5	Middle "c"	Slow	Complete; quickly established	Strong Withdrawal	No Effect	Same	Same	Same	No	No	No Effect	
6	White Light	Slow	Complete; quickly established	Restored Uncondi- tioned C-R	C-R of sec- ond order	Restored Uncondi- tioned C-R	Not Given	Not Given	No	No	Negative C-R Formed	
7	Electric Bell	Fast	Complete; quickly established	Restored Uncondi- tioned C-R; im- paired differen- tiation	Not Given	Restored Uncondi- tioned C-R	Negative C-R Formed	Negative C-R Formed	No	No	Negative C-R Formed	
8	Electric Bell	Fast	Partial	Not Given	Not Given	No Effect	Not Given	Not Given	No	No	Negative C-R after 25 trials	



TABLE VI  
THE EFFECT OF ARTIFICIAL ACCELERATION AND RETARDATION OF BREATHING UPON SIMPLE AND DIFFERENTIAL C-Rs  
WITH SHOCK IN 5 SUBJECTS, 18-20 YEARS OF AGE.

Subject	Effect on Simple C-R (Percentage Incidence)				Effect on Differential C-R (Percentage Responses to Differential Stimuli)			
	Normal Breathing	Accelerated Breathing	Holding Breath	Control	Normal Breathing	Accelerated Breathing	Holding Breath	Control
1	100	54	40	100; 83*	0	0	0	8; 0
2	100; 100	14; 0	66; 0	100; 100	0; 12.5	0; 0	0; 0	9; 0
3	100; 100	0; 0	0; 0	100; 100	100; 100	0; 0	0; 0	100; 100
4	100; 100; 100	50; 40; 0	33; 0; 0	100; 100	0; 0; 11	25; 50; 50	0; 0; 0	11; 0
5	100; 100; 100	42; 57; 0	66; 0; 0	100; 100	0; 22; 12.5	75; 50; 0	100; 45; 0	0; 0

\* The figures separated by semicolons denote results from different experimental sessions and, in the case of the control experiments, from different parts of the same session.



Ilina and Lykhina (22) studied the effect of artificial acceleration and retardation of breathing upon simple and differential C-Rs in 5 subjects, eighteen to twenty years of age. Each experiment consisted of 2 parts: in the first part the subjects breathed normally, while in the second part they either held their breath or accelerated it to 60 times per minute. Control experiments with normal breathing in both parts were also conducted on the same subjects, but trials with normal and artificial breathing were apparently not rotated. The results are presented in Table VI, from which it would appear that both artificial dyspnoea and apnoea decrease the incidence of the simple C-R but that their effect upon the responses to differential stimuli seems to vary.

The effect of physical work or fatigue upon simple and differential C-Rs in 7 subjects, eighteen to twenty years of age, was studied by Abramovich and Pichugin (1). Each experimental session consisted of 2 parts, with intervals of 15-20 minutes between them, and about 20 trials of the C-R were given in each part. In the control experiments the subjects did nothing during the intervals, while in the fatigue experiments they either lifted weights of 20 kgs. 20 times or ran 300-350 meters. The results are presented in Table VII, from which it would appear that both the simple and the differential C-R were little influenced by the physical work.

The effect of the administration of alcohol upon the simple and differential C-Rs to middle "c" on a harmonica in 7 non-drinking subjects, 3 men and 4 women, were studied by Kantorovich (25). During the intervals of 10-15 minutes between the experimental sessions 100 c.c. of alcohol was administered to the subjects, the strength of the alcohol being 40 per cent for the men and 20 per cent for the women; control experiments with intervals of the same lengths were also conducted. The results are presented in Table VIII, from which it would appear that in most cases the alcohol impaired both the simple and the differential C-Rs. It may also be added that the alcohol increased the incidence of extra responses to no overt stimuli and of responses by the non-stimulated hand.

*Miscellaneous Experiments.* A carefully controlled investigation on the effect of the duration of conditioned stimuli upon their C-Rs was performed by Butorin and Silantyeva (14) in 7 subjects. After the simple and differential C-Rs with some duration of the conditioned stimulus became well established, experiments were begun with durations of 1, 5, 10 seconds in one series and of 1, 15, 30 seconds in another series (in one subject also with a duration of 60







seconds), each session being divided into 2 parts with intervals of 4-5 minutes between them. The results are presented in Table IX: the durations of the C-Rs in seconds and the magnitudes in percentage ratios of the average magnitude for some duration divided by the average magnitude of the total series. It may be seen from this table that longer durations of the conditioned stimuli gave longer responses but that the magnitudes of the responses seem to have decreased when the duration of the stimulus was over 5 seconds.

Two cases of peculiar conditioning of 2 female subjects, one left-handed and the other right-handed, are described by Schniermann and Oparina (38). The left-handed subject, who responded with both hands to a shock applied to the right hand, formed a bilateral C-R to the middle "c" on a harmonica after 138 trials. On the seventh experimental session when the C-R became well established and was no longer reinforced, the subject began to respond sometimes with the right and sometimes with the left hand, this kind of responding continuing for 2 more sessions. On the tenth session it was found that intervals of 3-5 minutes between trials favored right hand responses, intervals of 15-20 minutes left hand, and still longer intervals the right hand responses again. During sessions XII-XIII a few reinforcements were given and right hand responses began to predominate. The formation of a negative C-R to a combination of the middle "c" with a light or with a bell was later attempted but this C-R was not readily effected. However, on session XV the subject began to respond to sounds with the right and to lights with the left hand, and on session XVI to tones below "c" with the right and those above "c" with the left hand, but on session XIX, when a few more reinforcements were made the process was reversed, higher notes giving right hand and lower left hand responses.

A somewhat similar differentiation of the responses of the two hands was also obtained in a right-handed subject who had a C-R—with shock applied to the left hand—to middle "c" of a harmonica. When, after the subject's C-R had become well established, the middle "c" was combined a few times with the shock to the right hand, it was observed that the originally conditioned note would evoke a right hand response while other sounds would give left hand responses. When "g" of a lower octave was later conditioned with shock to the right hand, it, too, came to arouse right hand responses but the responding with the left hand was still the rule for other notes.

Bekhterev and Dobrotvorskaya (10) report the formation of a C-R of the sixth order in one subject, the first conditioned stimulus



TABLE VIII  
THE EFFECT OF 100 C.C. OF ALCOHOL OF 20-40% STRENGTH UPON SIMPLE AND DIFFERENTIAL AUDITORY C-Rs OF  
7 NON-DRINKING SUBJECTS.

Subject	Sex of Subject	Experimental Session at Which Alcohol Experiment Was Begun	Number of Experimental Sessions		Percentage of Incidence of Simple C-R		Percentage of Correctness of Differential C-R		Extra Responses (to No Overt Stimulus)		Responses by Unstimulated Hand	
			With Alcohol	With Control	Before and Control	After Alcohol	Before and Control	After Alcohol	Without Alcohol	With Alcohol	Without Alcohol	With Alcohol
1	M	12	3	4	95	80	100	90	None	None	None	None
2	M	9	3	3	100	50	100	95	None	Sporadic	None	None
3	F	2	1	1	100	75	100	75	Sporadic	Often	None	Insignificant
4	F	4	1	1	100	85	90	85	Sporadic	Often	None	Occur
5	M	12	3	3	100	100	60	30	Occur	Many	None	Occur
6	F	6	1	1	100	90	70	0	Seldom	Often	Sporadic	Often
7	F	6	2	1	100	90	35	70	Very Seldom	Seldom	Often	Seldom



being a light, the second—an electric bell, the third—middle “c,” the fourth—middle “e,” the fifth—“g,” and the sixth—“b.” However, as stimuli 4–6 were similar to the third stimulus and as no pre-experimental tests with them are reported, it is of course probable that the responses were the result of generalizations from the third stimulus and not of the formation of new C-Rs of higher orders.

### III. EXPERIMENTS FROM OTHER THAN BEKHTEREV'S LABORATORY

Watson (44) was the first non-Russian experimenter to have established C-Rs with shock in human subjects. He worked with 11 subjects, applying the shock at first to the toes, but later to the fingers. He reports that in the best subjects 14–30 combinations were required for the formation of the C-R to a bell, that a C-R established in one subject in May apparently carried over to October, when it appeared after only one reinforcement, but that one subject did not give the primary response to shock and another did not form the C-R with shock applied to the great toe. He also seems to have demonstrated experimental unconditioning, spontaneous restoration of unconditioned C-Rs as well as tactile, auditory and visual differential conditioning, although the differentiations seem to have been largely respiratory.

Hamel (18) investigated the formation and reaction times of C-Rs with shock in 23 subjects. His investigations consisted of two parts. In the first part, in which 13 subjects were used and no special time records taken, the conditioned stimulus was the touching of the volar surface of the subjects' forearms 6 cm. above the wrist by means of a special contact key. In the second part, in which 10 subjects were used, the conditioned stimulus was the sounding of a magnetic hammer and the subjects' reaction times were taken by means of a Hipp chronoscope; the voluntary reaction times of the subjects to the stimulus were also taken. The experimenter seems to have thought that even the formation of a simple C-R required the application of negative stimuli and thus applied continually without reinforcement tactile stimuli to the wrist in the first part of the experiment and the sounding of a bell in the second part. This procedure as well as the experimenter's somewhat confused conception of the C-R, such as excusing subjects who “caught on” to the experiment, vitiate little, however, his results, which have been throughout recorded objectively and are of considerable interest. They are thus summarized here in Tables X and XI and seem to be well in line with other similar studies.



TABLE IX  
THE EFFECT OF THE DURATION OF CONDITIONED STIMULI, COLORED LIGHTS, UPON THE MAGNITUDES AND DURATIONS OF THEIR C-Rs IN 7 SUBJECTS.

Subject	Conditioned Stimulus	Original Duration of Conditioned Stimulus	First Series						Second Series												
			Number of Experimental Sessions Tested	Relative Magnitude of C-Rs with Duration of Conditioned Stimulus of:	Average Duration in Seconds with Duration of Conditioned Stimulus of:				Number of Experimental Sessions Tested	Relative Magnitude of C-Rs with Duration of Conditioned Stimulus of:	Average Duration in Seconds with Duration of Conditioned Stimulus of:										
					1 "	5 "	10 "	1 "			5 "	10 "	1 "	5 "	10 "	1 "	5 "	10 "			
1	Red Light	1 "	12	123	105	72	1.80	1.90	1.6												
2	Raspberry Light	1 "	12	95	104	101	2.35	3.35	2.6	NOT TESTED											
3	Green Light	1 "	12	96	104	100	2.75	5.50	9.6												
4	Red Light	1 "	12	97	97	106	1.35	3.75	4.6				101	106	93						
5	Blue Light	1 "	12	101	98	101	1.95	2.10	2.35				106.5	99	94.5	2.6	4.45	3.6			
6	White Light	1 "	12	95	110	95	0.60	1.45	1.0												
7	Red Light	10 "	12	101	102	97	1*	2*	3*	12	101	97	102**	1*	5*	5*					
Average				101.1	102.9	96	1.54	2.58	3.25		102.8	100.7	96.5								

\* Number of C-Rs. This subject gave a few C-Rs when the duration of the conditioned stimulus was more than one second.

\*\* The magnitude of the response with 60 seconds duration was 96% of that with 30 seconds duration in this subject.



Prokofiev and Zeliony (35) report the formation of a C-R of the second order in an eighteen-year-old subject in the following manner: A metronome was associated for 10-second periods with a tactile stimulation 60 times during 20 days. When now the 2 stimuli were combined together for 2 additional trials and the tactile stimulation once with an electric shock, a C-R appeared to the tactile stimulus and after another combination of metronome and tactile stimulus also to the metronome alone. This C-R disappeared on the second trial, but 4 days later when 11 more associations of the 2 conditioned stimuli were made during 2 days and the tactile stimulus was twice applied with shock, the C-R to the metronome alone reappeared. In another subject sixteen years of age 11 combinations of the metronome with the tactile stimulus prior to 3 applications of the tactile stimulus with the shock were, however, unsuccessful in bringing about a C-R to the metronome alone.

TABLE X

THE FORMATION OF A TACTILE C-R WITH SHOCK IN 13 SUBJECTS

Subject	Total Number of Trials Made	Number of C-Rs Obtained	Trials before First Appearance of C-R	Stability of C-R (Consecutive C-Rs without Reinforcement)
1	140	0	..	...
2	40	0	..	...
3	138	19	65	3
4	218	29	78	13
5	210	64	29	6
6	29	1	28	Only once
7	104	24	14	2
8	116	26	32	3
9	78	20	11	4
10	83	2	34	Only once
11	56	8	20	Only once
12	7	1	6	Only once
13	Excused	..	..	...

Note: Volts through inductorium are stated to be 6 in the first 6 and 10 in the remaining subjects.

\* Number of C-Rs. This subject gave a few C-Rs when the duration of the conditioned stimulus was more than one second.  
 \*\* The magnitude of the response with 60 seconds duration was 96% of that with 30 seconds duration in this subject.



TABLE XI  
THE FORMATION OF AUDITORY C-Rs AND A COMPARISON BETWEEN  
C-R AND VOLUNTARY REACTION TIME IN 7 SUBJECTS\*

Subject	Total Number of Trials	Number of C-Rs Received	Trials for First Appearance of C-R	Number of Reinforcements after First Appearance	Average Reaction Time of C-Rs (in 0.001 of a Second)	Average Voluntary Reaction Time (in 0.001 of a Second)
1**	135	127	8	2	237.8	196.0
2**	102	101	1	2	162.5	176.8
3	132	111	21	6	201.4	198.7
4	62	31	31	7	385.0	241.0
5	67	18	17	Not given	364.0	Not taken
6	60	6	19	" "	364.0	" "
7	28	2	14	" "	755.0	" "

\* 3 other subjects were used only in a preliminary experiment.

\*\* Subject I was previously given 118 and Subject II 166 unsuccessful combinations of the conditioned stimulus with a weak shock.

Humphrey (20) experimented with simple and differential C-Rs to musical tones—produced by an instrument of the xylophone type—in isolation and in a musical sequence in 9 subjects. The results are, however, from only 3 subjects as 2 were excused, one could not form the differential C-R, and the remaining 3 subjects did not form the simple C-R—one after 800 and another after 1,000 trials. Of the 3 conditioned subjects, one seems to have developed a stable differential C-R to a note number 7 after a total of 486 trials, when 34 applications of the conditioned note elicited 32 C-Rs and 146 out of 158 applications of a differential note failed. The conditioned note was, however, unsuccessful in an arpeggio, scale, or melody, when a C-R appeared only once out of 21 times, although 38 out of 41 trials produced a C-R to the same note sounded in isolation in the same experimental session. Another subject gave 46 C-Rs to 64 soundings of his conditioned note in isolation and no responses to playing the note in a musical sequence 9 times, while a third subject whose differential C-R was not well developed gave 61 C-Rs to 77 applications of his



conditioned note in isolation and no C-Rs to the note played once in an arpeggio and twice in a melody.<sup>3</sup>

Scott (39) compared the conditionability of 10 subjects in a hypnotic state with that of 9 subjects in a waking state. The conditioned stimulus was a buzzer preceding the shock by 0.2 second and the intervals between trials were about one minute each. The results show a definitely greater conditionability of the subjects in the hypnotic state, all of whom were conditioned after an average of 14.2 trials, while in the waking state only 5 out of 9 subjects were conditioned with an average of 26.6 trials, the remaining 4 not being conditioned after an average of 30.3 trials. Nine of the 10 subjects conditioned in the hypnotic state carried over their C-Rs with smaller magnitudes to the waking state 15 minutes later, although they recalled nothing of the trance. The magnitudes of the C-Rs were smaller than those of the responses to shock but the magnitudes of the C-Rs in the first trials exceeded those of the 2 immediately following trials.

Schilder (36) seems to have been interested in finding out what the C-R means in terms of psychic processes. He thus flashed a light 5 seconds before the applications of a painful electric shock in 5 subjects, the combination of light and shock being given 15-20 times each experimental session and the subjects being experimented with for 3-4 weeks. The subjects' mental set was apparently to prevent the formation of the C-R but still in 2 subjects a few responses were given to the light alone. The introspective reports are too varied and descriptive to be summarized here. Bender and Schilder (12) attempted the formation of C-Rs to light or touch on the forehead in 18 catatonic subjects. Some subjects refused to coöperate and some showed little consistent response to the shock itself, but the remaining gave some sort of C-R very quickly, often after 1-2 trials.

Gibson, Jack, and Raffel (16) studied bilateral transfer of a C-R to a buzzer in 20 subjects, using the ordinary apparatus but taking no kymographic records. Nineteen of the subjects are said to have been successfully conditioned in 10-52 trials, although no data on the incidence of the C-Rs are given and 6 of the subjects are said to have showed some indication of responding to the buzzer before the conditioning experiments. Of the remaining 13 subjects, 8 are reported to have made definite withdrawal responses when the left hand, that had previously not been stimulated directly, was placed on the elec-

<sup>3</sup> The reviewer regrets that the experimenter presents his data in a manner that makes difficult a quantitative and indeed any comprehensive summary of the results obtained.



trodes and the buzzer alone sounded. Marinesco (29) reports the formation of a C-R to a metronome of 60 beats per minute preceding the shock by 10 seconds in a twenty-year-old astasia-abasic subject. The C-R appeared first on the second experimental day after 58 trials, then disappeared for 16 trials but reappeared the next day after 5 trials, when it was elicited consecutively 24 times. Patra and Jalota (33) report the formation of a C-R to a bell in 2 subjects, the stimuli being presented simultaneously and the intervals between trials being 2 seconds. In one subject the C-R appeared after 39 combinations and was elicited 8 consecutive times after 58 and 11 consecutive times after 89 combinations, while in the other subject it first appeared after 83 combinations.

Wolfe (45-46) made 2 rather extensive studies of the effect of

TABLE XII  
THE EFFECT OF THE TIME INTERVAL BETWEEN THE CONDITIONED STIMULUS  
AND THE ADMINISTRATION OF SHOCK UPON THE INCIDENCE OF THE  
FORMATION OF THE C-R. (AFTER WOLFE)

Study	Interval in Seconds	Number of Subjects Used	Percentage of Incidence of Conditioning
FIRST STUDY (Results from one Session only)	1.56 before shock	10	8
	1.25 " "	10	12
	1.00 " "	10	14
	0.75 " "	10	22
	0.50 " "	10	37
	0.25 " "	10	29
	0.00 " "	10	19
	0.25 after "	10	13
	0.50 " "	10	10
SECOND STUDY (Average for Sessions 1-3)	3.0 before "	6	3
	2.0 " "	5	0
	1.0 " "	5	5
	0.6 " "	5	34
	0.4 " "	7	23
	0.3 " "	7	58
	0.2 " "	7	51
	0.0 " "	7	10
	0.2 after "	7	10
	0.6 " "	6	11
	1.0 " "	5	12
	1.2 " "	6	6
Control	0.3 before " (Average for Sessions 4-6)	6	64



the time interval between the application of the conditioned stimulus and the shock on the formation of the C-R. In the first study 9 intervals—differing by 0.25 second and ranging from 1.5 before to 0.5 after the administration of the shock—and 10 subjects for each interval were used. The experimental sessions lasted for 55 minutes, and 400 trials, 3 of every 20 of which were test trials, were made each session. In the second study 12 intervals ranging from 3 seconds before to 2 seconds after the shock were used with 5-7 subjects for each interval; a special control group of 6 subjects with intervals of 0.3 second before the shock was also used. The experimental sessions lasted for 40 minutes with 200 trials, in the last half of which 10 random tests were made. Each subject was experimented upon for only one session in the first study but for 3-6 sessions in the second study; the conditioned stimulus was throughout the tapping of an armature of a solenoid on an iron plate.

The results are presented in Table XII, from which it may be seen that the highest incidence of conditioning was obtained when the conditioned stimulus was applied 0.2-0.6 second before the shock and that with other intervals the conditioning was very slight, intervals of 0.6-3.0 seconds before the administration of the shock or even simultaneous presentation of the 2 stimuli being little more effective than the application of the conditioned stimulus 0.2-1.2 seconds after the shock. The last finding is definitely in disagreement with other results and the reviewer ventures to attribute the discrepancy to the experimenter's massing of the trials too closely together, with intervals between separate trials as a rule less than 10 seconds. Such close succession of individual trials might on the one hand increase the incidence of backward conditioning by conditioning the conditioned stimulus of one trial to the shock of a subsequent trial and, on the other hand, decrease the incidence of forward conditioning by weakening the effect of the shock through its conditioning to the conditioned stimulus itself, the last supposition having been shown by Beritoff (I. S. Beritoff—*Individually Acquired Activity of the Higher Nervous System*. Tiflis, 1932, pp. 470). As to the effect of the number of reinforcements upon the incidence of the C-R, the experimenter states that from period to period in the second study 18 subjects showed no constant change, 8 showed increase, and 20 decrease in the incidence of the C-R (25 subjects were not conditioned at all). This is, of course, in line with results of other experiments in human conditioning with shock, as pointed out by the reviewer above (footnote 1).



Thorndike and Lorge(43) report attempts to develop C-Rs in 53 subjects. The conditioned stimulus was a bell sounded for 2 seconds and continued together with the shock for 2 additional seconds. Each experimental session lasted for 2 hours, during which as a rule about 500-1,000 trials were made, the ratio of reinforced to that of non-reinforced trials of the conditioned stimulus being 4 to 1. Of the 53 subjects the records of only 31 are available as 6 subjects were disqualified—2 for fear of apparatus, 2 because of original

TABLE XIII  
THE EFFECT OF THE APPLICATION OF A BELL WITH SHOCK ON THE  
FORMATION OF C-Rs TO A BELL IN 31 SUBJECTS  
(After Thorndike)

Subject	Total Number of Applications of Bell and Shock	Percentage of With- drawals to Bell + Shock	Total Number of Applications of Con- ditioned Stimulus Alone	Percentage of Incidence of C-Rs	Series of 25 Trials in Which C-R first Appeared
1	333	90	91	48	1
2	581	98	288	69	4
3	552	94	157	18	7
4	471	88	322	86	2
5	476	54	175	51	1
6	564	78	136	29	1
7	958	82	317	32	2
*8	347	70	77	49	1
*9	157	64	37	5	3
*10	411	75	91	48	1
*11	533	89	114	15	3
*12	66	29	4	25	2
*13	489	58	99	34	2
*14	131	29	18	17	1
*15	695	29	28	18	1
*16	86	35	9	0	Did not appear
*17	423	40	34	0	" " "
*18	253	56	57	47	1
*19	38	37	2	50	1
20	108	99	118	86	2
*21	77	44	12	25	1
*22	400	65	76	28	6
*23	133	19	11	0	Did not appear
*24	1423	86	313	25	3
*25	211	41	42	21	1
26	646	95	154	8	11
27	399	77	123	40	1
28	350	99	179	61	1
29	465	69	209	81	2
*30	83	59	48	85	1
31	99	100	92	77	1

\* Finally failed to respond to bell + shock 19-20 out of 20 times.



responses to the bell, and 2 because of no response to the maximum shock of the inductorium—and the records of the other 16 were discarded because of the supposed influence of volition, as determined by a questionnaire. The results are summarized in Table XIII, to which the following should be added. In 4 subjects, in whom the incidence of the C-R was high, experimental unconditioning was tried by giving the bell consecutively 91–110 times without reinforcements, but the unconditioning developed in only one subject, the remaining 3 giving 106, 105, and 106 C-Rs to 108, 109, and 100 respective soundings of the bell alone. The C-Rs of 2 of these 3 subjects were, however, eliminated when during 50 trials the switch was reversed and they were shocked whenever they raised their fingers.

Examining Table XIII, the reviewer questions the accuracy of the experimenters' statement that the C-R was rarely formed if at all and was obtained in only 8 per cent of the subjects and the need of their explaining the phenomena by mechanisms other than conditioning. The most striking result of the experiment is the fact that 18 out of 31 subjects finally failed to respond to the combination of bell and shock. Such failure might, however, be very well attributed to some fault of the procedure, probably to massing too many trials in one session. Massing might cause the weakening of the conditioning potency of the shock by the closely following bell, as pointed out above, and the weakened shock might have combined with the bell to form a response of the type of "conditioned inhibition" or negative C-R, as has been previously found in experiments combining an acid with certain strengths of shock. At any rate, the subjects' failure to respond to the conditioning stimulus cannot be held as evidence against the conditionability of the response, nor by any means generalized to other responses. Furthermore, the experimenter's criterion of failure as the non-appearance of a response for a certain number of consecutive trials is not in line with known facts of conditioning—such non-appearance being rather common in the transitory stage of conditioning—and more satisfactory results would have been obtained by further experimentation.

Newhall and Sears (31) experimented with the conditionability of light intensities near the absolute thresholds in 7 subjects. A tungsten projection lamp was the source of the light, which passed through a daylight filter and was deflected from a magnesium oxide surface to the subject's eye, while the intensities were varied by moving the lamp on a track in a long box; a low superthreshold fixation light from another lamp, appearing a fraction of a degree



above the stimulus light, was also used. Each subject participated in 12 sessions: one preliminary, 4 normal during which his absolute threshold was determined by 0.50 p. of the method of constant stimuli, and 7 conditioning sessions during which light stimuli of 5 low intensities—0.001–0.005 Troland's photons for 5 and 0.003–0.007 photons for 2 subjects—were associated with shock to the middle finger of the right hand. In the 4 normal sessions—2 preceding and 2 following the conditioning sessions—each subject was given a total of 120 experimental trials—24 with each of the 5 intensities of the light stimuli—and 24 control trials with the fixation light alone. The conditioning sessions were divided into 2 separate series of 4 and 3 sessions each, sessions in one series rotating with those of

TABLE XIV  
CONDITIONED RESPONSES OF 7 SUBJECTS TO 8 STIMULI NEAR ABSOLUTE THRESHOLDS (AFTER NEWHALL AND SEARS)

Intensities in Photons	SUBJECTS							Totals
	1	2	3	4	5	6	7	
0.007	Not taken	Not taken	Not taken	Not taken	Not taken	2	0	2
0.006	Not taken	Not taken	Not taken	Not taken	Not taken	0	0	0
0.005	7	9	4	6	8	2	0	36
0.004	8	10	3	8	6	3	3	41
0.003	6	8	1	4	7	0	0	26
0.002	3	6	0	3	2	Not taken	Not taken	14
0.001	0	2	0	1	0	Not taken	Not taken	3
(Control) 0.000	0	0	0	0	0	0	0	0
Totals	24	35	8	22	23	7	3	122
C-R below Subject's Psycho- Physical Threshold	3	2	0	4	2	5	3	19



the other. In the 4-session series each subject was given a total of 100 trials of light with shock, 20 trials with light alone, 20 control trials with shock alone, and 4 control trials with no extra stimulus, while in the 3-session series a total of 75 trials with light and shock, 30 trials of the light and no controls were made with each subject. Each experimental session lasted one hour, the conditioned stimulus preceding the shock by 0.5 seconds in 2 subjects, one second in 2 others, and by 2 seconds in the remaining 3 subjects. The main results are presented in Table XIV, from which it may be seen that, while the incidence of the C-Rs on a whole decreased with a decrease of the intensities of the conditioned stimulus, 19 C-Rs were elicited with stimuli below the subject's absolute thresholds (8 of these 19 stimuli were reported not perceived by the subjects). These results, while coming from a small number of cases, are of great interest as opening a new field of research in conditioning and should be repeated on a larger scale.

Sears and Cohen (40) report an interesting case of curing hysterical anaesthesia in a forty-five-year-old patient, whose left hand was completely anaesthetic to superficial touch, by what appears to be a C-R technique. After 50 combinations in one session and 10 in another of a quick brush of a wisp of cotton across the back of the left hand with an electric shock brought no results (the subject was told to raise her hand to the shock, the response not appearing spontaneously), the cotton was applied twice to the right hand but the C-R appeared to the right and not to the left hand even after 35 additional applications of the cotton to the right and 6 to the left hand. The third session a sharp rap with a pencil on the left hand combined with a shock produced a C-R which was given for 10 additional consecutive trials while on the twelfth trial the C-R appeared for the first time to the cotton applied to the left hand, the response being given 2 more times after 12 additional combinations of the shock with the rap of the pencil in the same session. On the next session, 48 hours later, the response was not given to either stimulus applied to the left hand but one reinforcement of the cotton with shock produced not only a C-R which was elicited in 17 out of 22 trials in the same session, but the subject also reported 16 times that the cotton was felt, and there was no evidence of the return of the anaesthesia for 6 months.

### III. DISCUSSION

A complete discussion of the place of the C-R in psychology is reserved for a future publication. Here it should, however, be added



that, while the withdrawal response to an electric shock is undoubtedly most useful in animal conditioning and of great interest in some special problems of human conditioning, its general value as a method for the discovery of the laws of conditioning in adult human beings is extremely limited. The fact that abnormal and subnormal subjects form the C-R very often in 1-2 trials, that subjects in a hypnotic state are more readily conditionable than those in a normal state, that some few normal subjects do not become conditioned even after thousands of trials and others show extreme variability and inconsistency in the speeds of their conditioning, and finally that formed C-Rs at times disappear for no objectively accountable reason—all would indicate that experiments with adult human shock conditioning—as well as experiments with other consciously reportable responses—have not normally yielded results of pure conditionability. While C-Rs are of course not brought about by “consciousness,” “attention,” “mental sets,” and the like—both because they are elicited when an assumption of these processes is gratuitous and because their correlations, if any, with these processes are negative—they are nevertheless affected, much more than the so-called native responses, by subjective processes and their true course obscured when the latter occur. The supposition that these subjective processes are themselves governed by laws which are the same, identical, similar, or derivable from the laws of conditioning does not remove the difficulty since the conditioning units of the subjective processes are not controllable or even identifiable.<sup>4</sup>

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<sup>4</sup> As the conditioning of only animals, young children, and consciously unreportable responses may presumably be considered free from the effect of subjective, symbolic, or subvocal processes, the C-R as a method is thus to supplement and not to supplant other psychological methods.



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PROCEEDINGS OF THE ROCKY MOUNTAIN BRANCH  
OF THE AMERICAN PSYCHOLOGICAL ASSOCIATION,  
LARAMIE, WYOMING, DECEMBER 1-2, 1933

GEORGE T. AVERY, *Colorado Agricultural College*

Meeting called to order Saturday morning, December 2, at Laramie, Wyoming, by President Thomas R. Garth.

The minutes of the previous meeting including the Constitution were read and approved. The Committee on Nominations submitted the following report:

President—George T. Avery, Colorado Agricultural College, Fort Collins, Colorado.

Vice-President—L. M. Miller, University of Denver, Denver, Colorado.

Secretary—J. D. Heilman, Colorado State Teachers College, Greeley, Colorado.

Treasurer—W. P. Reed, University of Wyoming, Laramie, Wyoming.

These were duly elected.

The Committee on Resolutions submitted their report as follows:

Resolved that the Rocky Mountain Branch of the American Psychological Association express thanks to the University of Wyoming for their splendid hospitality during the 1933 meetings of the Colorado Wyoming Academy of Science.

It was unanimously approved.

It was moved and seconded that the invitation of the Colorado Agricultural College of Fort Collins, Colorado, for the summer meeting, July 13 and 14, be accepted. This motion was unanimously passed.

It was also duly moved that the Rocky Mountain Branch of the American Psychological Association coöperate with the colleges of this area in extending an invitation to the American Psychological Association to meet at the Rocky Mountain National Park for the Annual meeting in 1935. Motion approved.

It was further moved, seconded and approved that a special invitation be extended to other colleges in the area not represented, to



meet with the Rocky Mountain Branch in the 1934 meeting to be held at the Colorado School of Mines, Golden, Colorado.

There being no further business the meeting adjourned.

The following program was rendered at the meeting in Laramie:

FRIDAY, DECEMBER 1—2:00-4:00 P.M.

1. "Sex Differences in Intellectual Abilities of Seventeen, Eighteen and Nineteen Year Old College Entrants."  
J. D. HEILMAN, Colorado State Teachers College.
2. "A Critical Analysis of the Peterson-Thurstone War Attitude Scale."  
L. M. MILLER, University of Denver.
3. "A Further Study of the Effect of Variation of Reward and Drive Upon Maze Performance in the White Rat."  
R. H. BRUCE, University of Wyoming.
4. "A Study of Ability to Recognize Faces."  
T. H. HOWELLS, University of Colorado.

SATURDAY, DECEMBER 2—9:00-12:00 A.M.

5. "The Administration of the Johnson Skill Test to Indians and Whites."  
G. B. JOHNSON, University of Denver.
6. "Factors Other than Intelligence Influencing Continuance in High School."  
LILLIAN PORTENIER, University of Wyoming.
7. "Incidental Observations on the Life and Habits of Guinea Pigs."  
G. T. AVERY, Colorado Agricultural College.
8. "A Four-Year Study of Freshman Ability."  
W. P. REED, University of Wyoming.
9. "Intelligence of Students in a Commercial College."  
R. J. TRIPLETT, University of Denver.



## BOOK REVIEWS

MARSTON, WILLIAM M., KING, C. DALY, and MARSTON, ELIZABETH H. *Integrative Psychology: A Study of Unit Response*. New York: Harcourt, Brace & Co., 1931. Pp. xvi+558.

The authors of this ambitious essay in objective psychology were impressed by the reaction of students to modern text books, a kind of bewilderment which may indicate failure in the unification of subject matter, undue abstractness and unfitness for practical application. In spite of much discussion of the nervous system, a natural and plausible integration of neurological and psychological phenomena is rarely achieved, so that some psychologists reduce references to the nervous system to a minimum, while others seem to introduce the subject as a mere matter of form.

An ideal system of scientific psychology should no doubt be objective, quantitative in theory, and universal, *i.e.*, applicable to every organism as behaviorists maintain, but this involves the exclusion of certain classes of phenomena, *e.g.*, consciousness. It must result in an incomplete genetic psychology, which would thin out, just where it should be most useful, *viz.*, in the account of human nature. Moreover, the demand for a universal psychology in directing primary attention to organisms remote in the zoölogical scale, and in attempting to endow observations in this field with an explanatory value for human psychology, involves a certain error in the evaluation of genetic data, since the specific structures, properties and functions of the synaptic type of nervous system are of vastly greater importance for human psychology than corresponding data from organisms of a non-synaptic type. Integration as a neural process arises only with the synaptic nervous system.

It is for this reason that Professor Marston and his collaborators retain consciousness in their psychological schema, characterizing the attitude of the behaviorists on this point as a childish non-sequitur from legitimate criticisms of earlier psychological methods. On the other hand they find it unnecessary to pursue the psychology of animals below the coelenterates and limit study to the sphere of integrative nervous systems, sacrificing formal universality to the more definite task of analyzing the activities of only such creatures as possess an integrative nervous system. In logical terms the



intension of the concept of psychology is of more importance than the extension.

With these limitations the authors proceed to develop a theory of the integrative mechanisms, on the basis of a historical and critical survey of past and present analyses of the fundamental human activities, and as they claim "a more detailed and comprehensive adherence to experimental findings in neurology and psychology than is usual in general psychology" (p. xv). The historical survey seems to show that all schools of psychology have been working toward the conception of a unit response or ultimate element of behavior analogous to the units of other sciences. The authors are convinced "that psychology to be practical must have its own elementary units of human behavior . . . which should be discoverable . . . according to available methods of experimentation, and objective, clinical observation. They should not be hidden in the genes of the germ plasm like instincts, nor should they be artifacts of another science like the conditioned reflex" (p. xiv).

This at once rules out spirit, soul, libido, instinct, and action tendencies on the one hand, and biological action tendencies, prepotent reflexes and reflexes, on the other, as useful behavior units, since all of these are either hypotheses or artifacts, and commit the psychologist in some degree to one of the twin biological fallacies of pure environmentalism or its opposite.

In postulating four elementary types of unit response "which may serve psychology precisely as the atom, electron, and proton have served chemistry" (p. xiv), the authors take their departure from the properties of the psychophysical energy of the organism and the energies of the environment when the two energies combine. The response of an organism is not mere acceptance and transformation of external stimuli, but rather an equilibration of internal and external energies. Indeed the authors hold, that "The key factor to human behavior is the constant activity set up within the organism, day and night, by neural and chemical processes within the body" (p. 41). Incoming activities must be reconciled with activities already going on, the result being an integration rather than a summation of energies. Since energies differ in direction and intensity, the possible types of unit response are limited to four, viz.:

Dominance, or opposition of energies with increase of activity.

Inducement, or alliance of energies with increase of activity.

Submission, or alliance with decrease of activity.



Compliance, or opposition with decrease of activity. All unit responses may be active or passive according to the attitude of initiative or non-initiative on the part of the subject. Separable parts of total unit responses are assumed corresponding to the three types of neuron necessary to the completion of a reflex circuit. These form three types of what the authors call, "psychonic reactions," involving a particular type of consciousness dependent upon "the psychon or junctural tissue within the synapse." Sensation, thinking and emotion are the specific forms of psychonic energy respectively associated with sensory connector and motor psychons. Each is a specific form of consciousness or expression of a specific psychonic energy, a view which makes consciousness a genuine determinant of response and subsumes the familiar idea of consciousness as a kind of conflict between the internal and external world of man. Attention is concentration of psychonic energy.

Whether this conception has any advantages over Troland's panpsychic theory of consciousness is questionable, although the authors regard it as a less metaphysical view. However, the exact nature of this energy remains at bottom as hypothetical as that of McDougall or C. G. Jung.

A large part of the work is devoted to the explicit motor activities of a complex order such as drives, motives, and emotions. A drive is defined as "an inner self determinative propulsion of the organism toward a selected type of environmental stimulus, and a new, self-originated ability to react to the selected type of stimulus in new ways with new types of unit response" (p. 167). Drives are built up of compound unit responses manifesting themselves in successive phases in the development of the drive. Thus the basic drives are hunger, sex, and procreation. Hunger exhibits successive phases of (1) desire, a compound unit response combining passive compliance and active dominance, and (2) satisfaction, a unit response compounded of active compliance and passive dominance, while appetite is due to simultaneity in the same compound responses. Similar analyses of the erotic and procreation drives are given.

The latter is considered the source of all creative behavior whether biological (originate) or social (transformation).

Motives defined as "causes inside the subject's organism which predetermine his reactions to external objects" (p. 219) include (1) drives, and (2) native integration mechanisms, determining the variety of unit response to stimuli, factors which may cooperate or conflict in producing reactions. Human motives can best be studied



and observed through their associations with component unit response motives both simple and compound.

In an interesting chapter on learning, recall, and intelligence, the authors reject the popular interpretation of learning in terms of the conditioned reflex, as based on a misconception of the nature of true reflexes. At best it accounts for learning of a low order, and some reflexes can not be conditioned while other conditioned reflexes are almost immediately lost. "The conditioned reflex instead of being cited as a fundamental type of learning, might afford an excellent argument against all possibility of ever learning anything at all" (p. 286).

Indeed Dr. Marston questions and discards Pavlov's concept of the conditioned reflex as far as psychology is concerned although he does "not discard the facts and experimental procedures which gave rise to it."

According to the principles of Integrative Psychology, "Learning is the process of synaptic modification in a special series or a particular order," while "recall is the reactivation of the synaptic pathways thus established by means of an entering group of clue impulses" (p. 290).

Clues appear to be patterns or configurations of impulses so that this view is perhaps an approach to that of Gestalt Psychologists. The authors incline to Thorndike's view that there is no such thing as general intelligence though they admit special intelligences as functions of personality type. Intelligence tests are treated with skepticism and assigned a merely relative value. It is suggested that intelligence "ought to refer to the simple efficiency or success with which the self activities of the organism shape incoming stimuli into unit responses maximally favorable to the development and organization of the self activities" (p. 296), a definition which departs widely from most current uses of the term but might gratify so-called self psychologists who make an ambiguous use of the term self.

Contemporary stress on the motor aspect of emotion or even identification of emotion with muscular and glandular response, invite the treatment of this topic in connection with preceding motor phenomena, such as drives and habits, though Dr. Marston and his associates first discuss cognitive processes as functions of adjustor neurons and psychons, and approach emotion in the chronological order of the part reactions in unit response. The psychology of the emotions is an autonomous field irreducible to those of sensation and behavior. Emotion in general is a function of the motor psychons,



and the various emotions differ according to the type of unit response involved, and the extent to which unit responses are combined. Affective tone depends upon the relation between incoming or phasic activities and self motor impulses during integration, pleasure being due to harmony, and pain to conflict.

An entire chapter is devoted to the bodily symptoms of emotions, and a review of experimental studies with suggestions as to fruitful types of future experimental work with a warning against too great reliance on the psychogalvanic reflex method of study. It appears that "systolic blood pressure changes," give the most reliable measurements of emotion, at least during deception, while the best experimental stimulus is to be found in properly devised moving picture episodes.

Passing reference has already been made to the integrative psychologists' view of sensation and thought as psychonic phenomena at sensory and connector neurons. "Just as sensation is the consciousness of the effect of external, phasic stimulation upon the already existent constant, or self stimulation of the organism, so thought is the consciousness of a given relationship existing between certain impulses or patterns of impulses in the correlations centers" (p. 372).

It is evident then that six types of relationship occur at the correlation psychons, viz.: S.S., S.C., S.M., C.C., C.M., and M.M. where S., C., and M. signify sensory, correlation and motor impulse groups. These correspond to the percept, practical meaning, attitudes (including purpose and will), concepts, emotional significance, and emotional introspection or self-consciousness, in the order named. Each of these relationships may be of dominant, compliant, submissive or inductive type in accord with the nature of unit responses involved, and as they grow complicated, comprehension, or compound unit response of the intellect and with increasing complication creative imagination and explanation arise, while at a still higher level of integration the complex intellectual processes of realization, origination and transformation emerge.

The last two chapters, as is fitting, deal with what is often regarded as the most baffling and inclusive category of psychology—Personality. But to the authors Personality is something devoid of mystery although of supreme importance to the organism. Personality is simply the total consciousness, but since from the standpoint of this book consciousness is energy, personality is "the sum total of that energy within the individual organism" (p. 497) and "is identical with the determining factor in each individual's life



behavior." There are three general types of personality pattern—viz., the love type, the appetitive type, and the duplex type in which the complex responses of love and appetite are equally balanced. Each type is divided into sensory, intellectual and emotional subtypes according to the part reactions emphasized in expression.

In this long analysis of Integrative Psychology no space could be devoted to the authors' competent treatment of the sense organs, nervous system, and endocrine organs, which justify the authors' claim to "a more detailed and comprehensive adherence to experimental findings."

In a work of collaboration, a certain amount of repetition is inevitable, and in an initial exposition of a system this may be justifiable, but it would seem that this work might profit by condensation. A considerable number of typographical errors catch the eye and such an error as "sacoplasm" for sarcoplasm is repeated. There is apparent confusion in the use of the terms atom and ion on page 89, and it is doubtless an error to list Robert Ingersoll among atheistic propagandists (p. 542). The passages selected to illustrate the views of other authors like McDougall and Jung could often be improved upon.

The authors are fertile in what they admit to be plausible hypotheses but are rather severe with regard to the hypotheses of other writers, and there is no adequate recognition of the relativity of psychologies. Excellent critics for the most part, some of their objections to introspective psychology seem specious and backed by an unhappy analogy. "Thinking about thought," they say, "results in a description of thought in terms of thought, a logical fallacy so obvious that it occurs in no other science than psychology. It is exactly as if a botanist should attempt to enlighten us regarding the apple, exclusively in terms derived from the apple" (p. 361). But one might suggest that the authors are attempting to enlighten us regarding unit responses in terms of unit responses.

Finally the doctrine of the six types of relationships underlying thought, while formally consistent with the system of integrative psychology, seems of little use save for purposes of classification.

The merits of the work, however, definitely outweigh such defects as may exist. Among such merits are the following:

The authors set themselves resolutely against the present tendency in some quarters to ignore or eliminate from psychology terms of recognized value and content, but which do not fit in with the pre-conceptions of certain theorists; thus consciousness, instinct, emotion,



and other recently debated terms, are retained and given a definite functional significance.

No less resolute a stand is taken against such one-sided attitudes as radical environmentalism, physiological fatalism, and the crude mechanistic views of popular behaviorism and objective sociology. Far from looking upon man as a mere machine run by environmental energies, they "regard the integrative mechanisms of human beings as a spontaneously operating device whereby the human organism may be completely freed from environmental or materialistic control" (p. 14).

The authors also point out the artificial simplification of psychological fact which often creeps in as a silent accompaniment to the application of the principle of parsimony in explanation, as exemplified in certain theories of the learning process and the nature of emotion.

Sharp and well merited criticism is directed to the growing carelessness in the use of the terms normal and abnormal, leading to the hopeless confusion of the idea of the abnormal "with the entirely different idea of a departure from the average."

Throughout there is an effort to avoid the unconscious lapse into physiology or philosophy which puzzles the readers of many psychological treatises.

On the whole this is an original and well organized work marked by ample learning, just criticism, and a constructive spirit. Integrative Psychology may come to constitute a definite new school, coördinate with behaviorism, hormic psychology, configurationism, and still older claimants of psychological hegemony.

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